PROGRAMMATIC HYDROLOGIC MANAGEMENT ENVIRONMENTAL IMPACT STATEMENT AND APPENDIXES

FINAL

October 1996

US Army Corps of Engineers
New Orleans District

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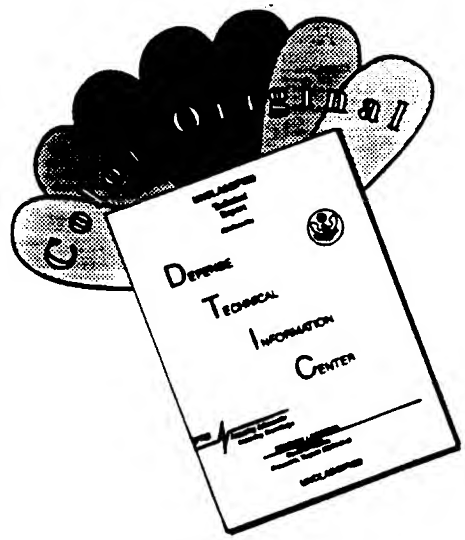

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REPLY TO ATTENTION OF:

October 1, 1996

Planning Division
Environmental Analysis Branch

NOTICE OF AVAILABILITY

The Final Programmatic Hydrologic Management Environmental Impact Statement (F-PHMEIS) and Appendices is available for review. Requests for additional copies should be sent to:

U.S. Army Corps of Engineers, New Orleans District
ATTN: Mr. Robert Bosenberg
CELMN-PD-RS
P.O. Box 60267
New Orleans, Louisiana 70160-0267

For convenience, copies of the document are also available for review at the following libraries:

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Written comments will be accepted any time during the comment period on the F-PHMEIS which extends from Friday, October 11, 1996, until Tuesday, November 12, 1996. Written comments should be submitted to Mr. Bosenberg at the address given above.

If you have any questions, please call Mr. Bosenberg at (504) 862-2522.

Sincerely,

R. H. Schroeder, Jr.
Chief, Planning Division

Enclosure

EXECUTIVE SUMMARY

Practitioners of hydrologic management (HM) in Louisiana's coastal marshes attempt to:

* set in motion a chain of events intended to culminate in the desired management outcome(s);

* take advantage of favorable meteorological, surface geomorphology and hydrologic conditions while and where they exist; and,

* regain hydrologic control as soon as possible after uncontrollable and unpredictable, counterproductive conditions (e.g., tropical weather systems, prolonged periods of little or no rain fall) pass.

As a result, the processes, structure and function that come to characterize marsh subjected to HM will differ from nearby unmanaged marshes.

Until about 10 years ago, improving habitat conditions for targeted marsh dependent animal species was historically the single most important reason to conduct HM. Since then addressing coastal marsh losses has emerged the foremost reason to pursue HM in Louisiana.

Through its regulatory obligations, the Corps of Engineers, New Orleans District (NOD) becomes involved in determining impacts and effects and balancing interests pursuant to rendering objective decisions for permit applications that would authorize the installation, operation and maintenance of structures and/or activities required to conduct HM efforts.

NOD's preparation of this PHMEIS is recognition of the potential for its permit decisions to have potentially significant effects. Since 1977, NOD has issued 98 permits for habitat improvement and/or marsh restoration. Of those permits, 71 were determined to be viable, collectively encompassing 495,020 acres. The HM efforts portrayed as desirable in the Coastal Wetland Planning, Protection and Restoration Act initiative clearly suggest that the trend to use HM to address coastal marsh losses is not likely to abate. The candidate HM efforts proposed in the CWPPRA Restoration Plan were used to analyze the impacts of HM within Louisiana's coastal zone. Thus, NOD may have to render decisions about permit applications that could involve as much as 551,546 additional acres.

Preparation of this PHMEIS revealed, among other things, that:

* There are no simple or definitive answers to questions as broad as: "How well do marsh management (MM) and hydrologic restoration (HR) projects work?"; "Why do they seem to work better in some places than others?"; and "What are the effects associated with hydrologic management (HM = MM and HR) projects?"

* MM has played a significant role in the history of Louisiana's coastal marshes. MM, and a recently evolved form of management- HR, are likely to see continued and wide-spread applications in the management of Louisiana's coastal marshes into the foreseeable future to address traditional management interests as well as combat historic, on-going and future marsh losses.

* MM is the traditional form of HM. Despite nearly 50 years of application and observation, scientific inquiry, and the issuance of permits by NOD with site-specifically formulated monitoring provisions since 1977, the longer-term and system-wide biological and ecological effects of one form of HM, marsh management (MM), remain to be conclusively documented. Typically, MM induces compensatory shifts in the structure and function of targeted marshes. Those shifts have historically focused on a few marsh-dependent animal species with differing socioeconomic values to several competing user groups.

* MM appears to be a predominantly short-term, site-specific solution to the long-term, wide-spread problem of marsh loss in coastal Louisiana. The reversal of historic or on-going marsh losses would be an optimistic representation of what MM could reasonably be predicted to achieve in the long-term on a repetitive basis at most sites. Forestalling future marsh losses or slowing on-going marsh losses in the short-term would be a more realistic representation of what MM could be expected to achieve for most applications.

* In all marsh types, MM can be used to generally improve habitat conditions for selected marsh-dependent mammals, and birds- especially migratory waterfowl, and expanding aquatic and emergent marsh vegetation coverages for short-terms. Thus, MM is likely to continue to have a role in the management of Louisiana's coastal marshes. However, when multi-thousand-acre MM efforts are undertaken in the more saline-influenced and mineral sediment-dependent marsh types, there are a number of adverse impacts to several significant physico-chemical and biological attributes that unavoidably occur.

* HR is a management approach with no track record. However, as an evolved form of MM, it is likely to induce many but not necessarily all of the compensatory shifts in the structure and function of targeted marshes as does MM. HR will also have socioeconomic implications, probably not too dissimilar from those associated with MM.

* There are programmatic potentials for significant effects, focused in the Chenier Region (especially the Calcasieu-Sabin Basin) and the Barataria and Terrebonne Basins of the Delta Region.

* Project-derived benefits from issued permits can often be expected to fall short of expectations. This is especially so relative to the number of permits and acreage encompassed by the no-work/expired and the pre-1994 partially implemented projects (that have also expired). The no work/expired projects were not always opportunities lost to address marsh losses but could be opportunities lost relative to other interests of the permittees. In the partially implemented/expired project areas, some detrimental, possibly destructive (some may be irreversible) effects to some significant biological attributes are also possible. Beneficial as well as detrimental socioeconomic implications are also possible.

* The socioeconomic effects of hydrologically managing Louisiana's coastal marshes can only be addressed in general terms. However, some of the socioeconomic conflicts related to HM appear to be irresolvable, even if HM ultimately proves successful at forestalling, slowing, stopping or reversing marsh losses.

* A comprehensive characterization of the socioeconomic implications of HM, greater compliance with monitoring provisions by permittees, better designed monitoring programs (as well as some additional rigorous scientific studies of selected biological attributes), and application of techniques to track/quantify cumulative effects would appear to be ways to improve the decision-making process.

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1.0. *INTRODUCTION*

Louisiana's coastal marshes were, still are and will continue to be a place to fish, hunt ducks, and harvest furs and oysters. Early on, those attributes defined the life styles of some (Ensminger, 1989; Davis 1993b) and are the foundation of the culture for others (Davis 1993b). Those same marshes are where a network of man-made waterways was created during the first half of this century to facilitate navigation-related economic enterprises and where oil and gas exploration and extraction efforts have been on-going for nearly a century. Projects to protect the economic infrastructure of south Louisiana from flooding initiated during the earlier part of this century are also a prominent factor that has, is and will continue to shape the future of Louisiana's coastal marshes.

Unfortunately, Louisiana's coastal marshes are disappearing. They have been disappearing, are disappearing and could continue to disappear, even if wide-spread, site-specific corrective actions are taken. Marsh losses have affected, are affecting and will continue to affect members of various walks of life as well as the social and economic dynamics of communities and the State of Louisiana.

Public concern about the consequences of Louisiana's marsh losses has precipitated amendments to the Louisiana state constitution and captured the attention of the Congress of the United States with the passage of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA).

The perception of the functions and values of coastal marshes in general has and is undergoing change (de la Cruz 1976b). There are biological, social, cultural and economic values associated with Louisiana's coastal marshes that were unknown, not readily apparent or undervalued just 30 years ago.

How fast those values and functions are diminished as the marshes disappear is related to a suite of factors, including geologic history and processes, soil type, and the individual and interactive effects of surface activities (e.g., flood control, navigation improvement projects, oil and gas activities, wildlife management, marsh protection). Because these and other factors differ throughout the coastal zone, historic loss rates and reasons differ depending upon where in the coastal zone you are. However, loss rates seem to be generally slowing (Dunbar et. al., 1990; Dunbar et. al. 1992). Although a very few areas appear to be stable or even accreting, such areas represent a departure from the likely overall trend of continued marsh

losses.

Louisiana's coastal marshes are recognized as hydrologically driven systems that are far more complex structurally and functionally than previously imagined. Nearly all have been modified to some degree by man's prior activities.

Management of marshes is seen as part of the solution. Proponents of management often assert their belief that man has a responsibility to take corrective actions.

Solutions to coastal marsh loss are wanted. The social, economic and environmental implications of marsh loss are significant. Concern for those implications is shared mutually by landowners, lease holders, land managers, resource user groups, academicians and government agencies.

Site-specific approaches to dealing with marsh loss and marsh dependent resources are appealing and part of the answer. Landowners, leaseholders and land managers prefer to implement cost effective projects in a timely manner that can address marsh-related interests on a site-specific scale (e.g., lease limits, property boundaries). Site specific projects are attractive to landowners, leaseholders or land managers because costs can be controlled and the project can be designed and constructed fairly quickly and operated specifically to meet their objectives. Diversions of freshwater and/or sediments are an alternative but they typically take significantly more time to design and implement, often require the construction and maintenance of ancillary features, and generally can't be exclusively controlled by the affected land holding interests.

Typically, there is a lack of definitive/factual information and documentation about why a particular marsh has eroded and continues to erode. Knowing precisely what factors interact in what fashion to cause a specific marsh to erode is a fairly uncommon occurrence (Cahoon and Groat 1990). Thus, solutions reflect a combination of local historical knowledge from the landowner/leaseholder as well as informed opinions and often some guesswork by practitioners of management. Accordingly, people that want to implement solutions to marsh loss rely upon several sources of information to surmise the reasons for the observed marsh loss at a given location.

Solutions to address marsh losses typically reflect the permit applicant's perception of the cause(s) of marsh loss as well as other management objectives. Multi-purposed management efforts are currently popular but management efforts designed to manage marsh acreages for singular purposes are still pursued.

Projects to stem marsh losses on a site-specific scale and/or that target marsh dependent species typically call for some dredging, the construction of water control structures and/or the placement of dredge or fill material. Dredging, constructing water control structures and the placement of dredge or fill material are activities that, when done in marshes or tidal waters, require Federal permits. In most instances, a state-level permit is also required and must be issued before a Federal permit can be issued.

The effectiveness of site-specific management efforts is seldom comprehensively documented. The impacts, individually and cumulatively, of marsh management are also poorly understood and documented. The existing information about the effects of marsh management (MM) is persuasive or conclusive on only some of the cogent aspects of marsh management (Cahoon and Groat 1990), but subject to varied interpretations, or simply lacking about many others. This interpretative latitude and lack of information is largely the reason there is a dispute about what marsh management and hydrologic restoration can and can't be counted on to do. The lack of definitive insight and understanding complicates the permit decision making process because consideration of cumulative impacts is a mandated part of every permit evaluation performed for each permit requested.

Predicting future conditions of specific marshes, with or without management actions in place, can be done only in general terms, which reduces accuracy. This is a problem for all people interested in marshes. With little conclusive or persuasive information about many of the important aspects of managing marshes, reliance upon the professional judgement and insight of the involved scientists often becomes the primary analytical approach as well as the basis for professional disagreement.

Hydrologic restoration evolved from marsh management. *Marsh management* (MM) is the management option of choice when a project's objective(s) and goal(s) probably cannot be achieved merely by emulating some historic, often natural, hydrologic condition. A decision to employ MM is evidence that the manager concluded that acquiring and retaining the capability to create and control (to various degrees) the hydrologic conditions within the targeted marsh is probably absolutely essential if the goals and objectives of the project are to be achieved. Structures are located, and some may be manipulated, in an attempt to control when and how much water of what quality is within the managed area at any given time.

Hydrologic restoration (HR) is often the management option of choice when a manager's objective and goal probably can be achieved by recreating conditions that emulate some historic, often natural, hydrologic condition in the marsh targeted for management. Often structures are used to reduce the influence of erosional forces.

Hydrologic management (HM) is a term created and used in this F-PHMEIS. It refers specifically to projects that attempt to achieve goals (e.g. marsh restoration, waterfowl habitat improvement, protection of property rights) by using man-made and/or natural landscape features to:

a) intentionally affect selected attributes of the hydrology of surface waters, yet
b) maintain some amount of two-way surface water exchange between a managed area and adjacent areas.

The NOD coined this term to more precisely limit the scope of this HMEIS to MM and HR. For example, sediment or fresh water diversion projects or impoundment management projects cannot be HM projects because the operation, design or selected controlling structure(s) make no provision or intent for two way exchange. Using HM also allows us to focus more on programmatic impacts and effects associated with the use of the same sorts of structures. Thus, determining whether a project is more properly labeled for permit evaluation purposes as a MM or HR project is secondary to an analysis of project particulars usually only made available when analyses of individual projects are initiated.

<u>Requests to implement updated designs typically happen before the effects of the updated designs can be scientifically documented.</u> Permit requests will almost always precede the availability of substantiating scientific documentation. Thus, reliance upon best professional judgement, often of anecdotal evidence, is commonly a facet of the permit decision making process.

<u>The permit applicant is entitled to and receives a balanced decision.</u> The permit decision making process is strongly and unavoidably influenced by professional judgement. However, an applicant's stipulated purpose(s) and need(s) are part of the framework of the process. So, too, are social and economic factors. Only when all the biologic, social and economic information needed to make a decision is assembled through the efforts of the applicant, interested parties and the Corps of Engineers and evaluated by a Corps permit manager is a permit decision made. Acquisition of the necessary information and forging mutually acceptable consensus understandings between all involved interests have

been the most time consuming stages of the permit decision making process.

The title of this document is different than was advertised in the Federal Register. The title may be different but the subject is still the same. When the Corps of Engineers - New Orleans District (NOD) published its Notice of Intent to Prepare an Environmental Impact Statement on Marsh Management, marsh management was the only term in use. However, the terminology has expanded to identify another option for managing Louisiana's coastal marshes. That other option is hydrologic restoration - HR. Both management options involve manipulating hydrology. Depending upon the stipulated purpose(s) and need(s), they can but need not be alternatives. Accordingly, NOD chose to address both in this document and concluded that Programmatic Hydrologic Management Environmental Impact Statement (PHMEIS) was a more accurate representation of the subject matter.

1.1. **Public Scoping Meeting Issues Addressed in This PHMEIS**

Detailed narratives are presented in the **SETTINGS** chapter of this EIS.

1.1.1. Social and Economic Issues

NOD **is** required to disclose and weigh the social and economic impacts and effects of a decision to issue or deny permits for regulated activities. Therefore, NOD has prepared an assessment of the socioeconomic implications attributable to MM and HR at a programmatic level.

Notably, the following concerns were expressed in the public scoping meeting but do not represent the entirety of NOD's assessment.

1.1.1.1. From the Landowner/Leaseholders Viewpoint

1.1.1.1.1. Limiting Public Access

There appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

1.1.1.1.2. Protecting Values Associated with Marsh Ownership

There are apparently two components to this concern: 1) preventing the loss of mineral rights/royalties; and, 2) capturing the economic values of harvestable marsh-dependent resources.

1.1.1.2. From the Viewpoint of Members of the General Public Who Have an Interest in Marsh-Dependent Resources

1.1.1.2.1. Limiting Public Access

As was the case with the landowners perspectives, there appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

1.1.1.2.2. Harvest

As we appreciate this issue, it has three parts: 1) public resources do not become private property simply by moving into privately owned marshes; 2) public resources, even when resident on private land, should be accessible by the public; and, 3) interfering with the free movement of fisheries organisms between privately owned, controlled access areas and publicly accessible areas adversely effects the culture, life style and economic fortunes of many people.

1.1.1.3. Small Scale Water and/or Sediment Diversion

Deliberate small-scale, typically seasonal diversions of water and/or sediment into managed areas are features of some past and future MM plans. They are often characterized as a phase of an actively managed area. Small diversions will be assessed in this programmatic EIS.

1.1.2. Scientific Issues

This encompasses a number of scoping meetings items. Accordingly, this PHMEIS examines the implications of HM (MM and HR) on the physico-chemical and biologically significant attributes of Louisiana's coastal marshes, as well as many of the socioeconomic implications.

1.2. Public Scoping Meeting Issues Not Addressed in This PHMEIS

The reasons for not addressing these public scoping meeting issues in this PHMEIS are stated.

1.2.1. Project-specific details

Particulars like specific structure designs, numbers and kinds of structures that comprise individual proposed plans, monitoring provisions, etc., are unique to each project and are properly evaluated as part of the assessment performed by NOD of each permit request. Addressing these matters in this programmatic context would be redundant, would

unnecessarily and unavoidably constrain the permit evaluation process and focus on too small a scale. Therefore, those aspects of HM will not be discussed in detail in this EIS.

1.2.2. Legal

Legal proceedings are an attempt to gain administrative relief from the effects structures (and management) may have on underlying, and apparently conflicting, social and economic interests. The reader is asked to refer to Wilkins (1990) for an extensive treatment of many of the legal issues surrounding MM.

NOD acknowledges that legal proceedings could be an indirect consequence of MM. However, NOD is **not** empowered to resolve legal questions. Accordingly, NOD will **not** attempt to resolve legal questions. Neither will NOD knowingly issue a permit that conflicts with Federal, state or other laws, nor will it attempt to anticipate where legal issues might arise in the future beyond issues brought to our attention through coordination with Louisiana State Lands and Louisiana's Attorney General.

1.2.3. Independent Management Actions

When the following actions are proposed as stand-alone and complete projects, they are evaluated and may be undertaken pursuant to other permit provision established by NOD or the COE, unless otherwise noted. Therefore, they will not be assessed in this programmatic EIS.

1.2.3.1. Burning

Marsh burning is a management practice that is not regulated by either the state or the Federal government. Burning can be used to: 1) adjust the composition of some marsh plant communities to favor primarily furbearers and secondarily waterfowl, and/or 2) to reduce the incidence of uncontrollable, lighting-ignited fires that could burn the peat portion of the marsh soil profile.

1.2.3.2. Planting Vegetation

Planting marsh vegetation is a proven and effective approach to address wave-induced shoreline erosion and accelerate revegetation in many but not all situations. The State of Louisiana passed legislation controlling the sources, production and sale of plants in order to protect natural existing vegetation, and Federal agencies must also obtain consistency for the Louisiana Department of Natural Resources, Coastal Management Division for vegetative

planting projects.

1.2.3.3. Site Preparation for Vegetative Plantings

However, permits may be needed from either the state and/or Federal government if preparing a site for a vegetation planting means raising the elevation of the substrate in a wetland situation (**Section 404**). Some site preparation activities for plantings, as stand-alone and complete projects, can be authorized by NOD in a general permit (**NOD-100**) specific for actions within the Louisiana Coastal Zone. Additionally, NOD holds that determining the implications of preparing a site for vegetative planting as a component of a more elaborate management plan is appropriately undertaken as part of the individual MM permit review process much as we would do regarding the number of structures. Therefore, adjusting elevations solely to facilitate a marsh plantings will not be addressed in this EIS.

1.2.3.4. Wave Dampening Devices

This is an effective way to site-specifically diminish shoreline erosion. It usually isn't controversial, can be installed as a complete and independent action to control erosion and typically isn't a critical element of any MM plan. For example, tire structures, Christmas tree cribs, and sediment fence structures are usually installed in shallow water along a specific reach of marsh or beach where the mechanical action of wind- or/and watercraft-induced waves against the shoreline cause(s) erosion. When installed in a navigable or tidal water, they require a Federal permit (Section 10), and may require a 404 permit as well.

Applications for permits to install such devices would be evaluated for environmental impact as part of the mandatory review process.

1.2.3.5. Rehabilitation of Existing Water Control Structures

A project limited in its entirety to simply rehabilitating existing functional and serviceable water control structures when the design and function are not changed is already an authorized activity either under provisions of existing permits or under provisions of **(Nationwide Permit # 3)**, provided the footprint of any associated fill is not expanded beyond the limits of any previously existing filled area. This work could occur whether or not it was part of a MM effort.

However, as part of a new HM effort, it would be evaluated as a component action of the HM effort. Thus, rehabilitations of existing structures would be evaluated during NOD's evaluation of the requested permit for MM/HR.

1.2.3.6. Large Scale, Uncontained Diversions of Water/Sediment

The typical large-scale diversion project introduces or shunts water into an open marsh system with the intent of being the principal action required to arrest the erosion of several hundred to several thousand acres of marsh. Accordingly, this is perceived as an alternative to HM, as was the treatment given this marsh erosion control effort in the CWPPRA programmatic EIS.

Additionally, government agencies are usually involved because of the scale, expense and planning effort typically involved. If undertaken as an action of the Federal government, such projects would be reviewed for environmental impacts during the project planning process.

Manipulating how much and when water and sediment is introduced or shunted into a marsh as well as how much sediment the water carries are all hydrological factors important to marsh managers.

1.2.3.7. Mariculture

Mariculture is an effort to enhance the economic return from estuarine marsh dependent fisheries on a commercially profitable scale. The Louisiana Legislature has taken a position of proponency by requiring mariculture efforts be undertaken only on a limited basis and only in concert with state-approved MM plans.

Mariculture and MM involve actions or the use of structures that require permits from the Federal and/or state government. There are two forms of mariculture: 1) cage culture and 2) "ranching." Cage mariculture and management of marshes can be pursued independently and neither is a biological prerequisite of the other. Thus, linking these two actions is viewed by NOD as an independent administrative action of a state agency. Placement of the cages, however, does require a permit pursuant to **Section 10,** and would be assessed accordingly. Ranching, however, involves culturing organisms in a marsh purposefully isolated from the surrounding estuary to facilitate a mariculture operation. Although management of the marsh may occur, it is a subordinate perhaps even complimentary action. Thus, the **Section 10/404** permits that would be required to create an isolated marsh situation within which

a "ranching" operation could be conducted would be subjected to an evaluation focused on mariculture and not HM.

Accordingly, an evaluation of cage or "ranching" forms of mariculture will not be included in this programmatic EIS.

2.0. *PURPOSE, NEED AND DEFINITIONS AND CONCEPTS*

The New Orleans District's (NOD) **purpose** for preparing this Programmatic Hydrologic Management Environmental Impact Statement (PHMEIS) is to objectively disclose the reasonably foreseeable impacts related to: 1) NOD's permit decisions relative to installing and operating structures to manage marshes in coastal Louisiana since 1977; and 2) those impacts plus impacts from issuance of permits for similar activities for the next 20 years.

NOD sees the following **needs** for the document:

1) address NOD's legal considerations,
2) provide an information-rich document that profiles the factors NOD considers when evaluating hydrologic management (HM) permits, and
3) be generally useful to regulators, agency personnel, managers and members of the general public alike

The NOD does **not** represent this PHMEIS as the definitive predetermination of any future requests to manage Louisiana's coastal marshes. To the contrary, such an action on NOD's part would be improper. NOD is obligated by law to determine the disposition of each permit request individually on the merits, taking into consideration the comments of the public and the overall public interest for each and every request. However, NOD expects that individuals familiar with this document will be better prepared to comment, assess and determine the relative strengths and weakness of each proposal to manage a marsh, and understand the basis for individual permit decisions.

The NOD does **not** represent this PHMEIS as, and did not prepare it pursuant to formulating, a policy on the management of coastal marshes and, therefore, cautions the reader accordingly. NOD's past, present and future position on the matter of managing marshes has been, is and will continue to be founded upon the constraints and obligations imposed upon the NOD by existing Federal laws and existing published guidelines we use to evaluate all permit requests that come before us. NOD regards the formulation of a 'policy' specific to management of coastal marshes as a separate, optional initiative, possibly better attempted by all involved Federal and state agencies. NOD expects that this PHMEIS would be valuable to us or any agency or body inclined to exercise that option.

2.1. NOD's Legal Considerations

2.1.1. Corps/NOD Regulatory Permit Program

The Corps of Engineers (Corps) has the administrative responsibility to issue Federal permits for the installation of structures and certain activities that occur within wetlands and other waters of the United States. That responsibility is vested in two Federal laws.

The River and Harbor Act of 1899, as amended, authorizes the Corps to issue permits for the installation and maintenance of structures or for dredging in navigable waters of the United States.

The Clean Water Act of 1972, as amended, authorized the Corps of Engineers to issue permits for the placement of dredge or fill material in waters of the United States including wetlands. The Clean Water Act authorized the Environmental Protection Agency (EPA) to promulgate the 404 guidelines and oversee the Corps' administration of the permit program. Specifically, the Corps administers Section 404 of the act.

In tidal waters, dredging and placement of material to construct and/or maintain levees, the installation of weirs (wooden or rock), culverts, or gates, are examples of activities or structures that are regulated under Section 10 of the River and Harbor Act.

Placement/disposal of dredged material in wetlands to create levees or to install weirs or culverts are examples of activities that are regulated under Section 404 of the Clean Water Act.

Accordingly, actions or structures commonly associated with the installation, operation and maintenance of structures to manage marshes, as addressed in this programmatic EIS, have and will continue to require the issuance by the NOD of one or both of the above mentioned Federal permits.

The Corps has published the rules it uses to carry out its regulatory responsibilities in the Federal Register. Those rules stipulate what the Corps is required to do for each permit decision it renders.

Regarding its general regulatory responsibilities, 18 general policies are listed. Each is addressed individually on a case-by-case permit request basis when applicable. To name a few, the Corps' rules include policies on what to consider relative to the public interest, wetlands, fish and wildlife, water quality, historic, cultural scenic and

recreational values, consideration of private ownership, activities affecting coastal zones, energy conservation and development, environmental benefits, and economics.

The public interest, briefly, requires the Corps to consider the likely individual and cumulative effects of the proposed project or action on 21 specific factors, and stipulates that a permit will be denied if the proposed action is contrary to the overall public interest.

The 404 (b)(1) Guidelines that the Corps administers were published by the EPA in the Federal Register. The Guidelines require the Corps to make a factual determination for each applicable permit case relative to the individual and cumulative effects of the proposed discharge/disposal to include direct and indirect as well as secondary effects. In order for the Corps to issue a 404 permit, the proposed discharge must comply with those guidelines.

2.1.2. National Environmental Policy Act (NEPA)

Issuance of a Federal permit by NOD is a major Federal action. When the impacts of such an action can have a potential or actual significant effect on the quality of the human environment, the agency taking such action is obligated under provisions of NEPA to disclose the nature of those impacts to the public. That is accomplished by the action agency preparing an environmental impact statement (EIS).

This PHMEIS is being prepared because the NOD believes that some, but not necessarily all, impacts and effects of HM (i.e., marsh management and hydrologic restoration) are scientifically and socioeconomically controversial and, if not already, could become potentially significant in a cumulative context. The potential for significance would stem from the multiplicity of interpretations that have been advanced and can't be substantiated or refuted regarding the potential biological effects of HM from the existing biologically specific data sets. The social and economic controversy stems from the fact that Louisiana's marshes are a limited and declining resource for and about which multiple and conflicting user interests are competing. Definitive economic or social information pertaining to the linkages and effects of marsh management and hydrologic restoration does not exist, thereby adding an element of professional subjectivity to permit decisions. The advent of CWPPRA has increased the potentialities.

This EIS is programmatic. That means that it focuses on the effects of HM actions in general rather that on a particular or specific permit request or project type.

NOD is required by law to comprehensively consider cumulative impacts when evaluating permit requests. NOD is aware that the already permitted marsh management areas, amounting to several hundred thousand acres, in addition to areas that might be permitted in the future, might affect unmanaged portions of the Louisiana coastal zone as well as the biological resources, including man, that depend on coastal marshes for life requisite resources. These kinds of impacts are termed cumulative impacts and are addressed in this EIS.

2.2. Document Utility, CWPPRA and Trends

2.2.1. Utility

Why does it take so long to get a permit for something so seemingly beneficial as MM and HR, especially since they are CWPPRA project types? The answer to this single questions seems to encapsulate much of why this PHMEIS is being written.

The answer is complex. First and foremost, however, it is founded upon and can be no more accurate than the certainty of the consequences of managing Louisiana's four coastal marsh types and included open water areas within a nearly 4.5 million acre area. Thereafter, it also requires an understanding of what NOD is legally obliged to consider when evaluating management permit requests. That, in turn involves knowing how the other Federal and state agencies, as well as the various concerned public interest groups, perceive the consequences of marsh management and hydrologic restoration and respond to obligatory solicitation from the NOD for public comments concerning requested HM permits. It also involves an understanding of how management of coastal marshes relates to the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). Finally, it requires recognition that the apparent prevailing public opinions about the permit process in general ranges from seldom satisfied to being exasperated with a perceived unnecessary and long-drawn out procedure reflective of the uncoordinated comments of intrusive agencies whose comments and contributions often seem counterproductive. The PHMEIS was written to address all of those considerations.

2.2.2. CWPPRA

Since about the early 1980's, increasing recognition of the biological, social, economic and political implications of unchecked losses of Louisiana's coastal marshes has made those losses more visible. Consequently, individuals, typically acting independently of one another and on a very localized scale, stipulated marsh losses a purpose for

requesting the necessary Federal and state permits to protect/manage discrete parcels of marsh.

The advent of the Coastal Wetlands, Planning, Protection and Restoration Act (CWPPRA) was recognition that the unchecked loss of the nation's coastal marshes in general was in fact the erosion of a significant national resource. CWPPRA called for a comprehensive, multi-agency planning and funding initiative by Federal and state governments to help stem the loss of coastal wetlands, inclusive of those in Louisiana.

The Louisiana CWPPRA Task Force was formed and through an exhaustive and broad-based public solicitation process received many proposed solutions. The several project types that evolved from that process were enumerated, categorized, characterized, and generally compared one-to-another relative to their applications for dealing with coastal marsh losses in a programmatic EIS published by the Task Force. Impact characterizations were limited to general representations for each project type. That programmatic EIS did not address in detail the large scale implementation of any of the project types.

Inclusion of MM and HR in CWPPRA and the benefits derived from those project types in slowing, stopping or reversing marsh losses did not exempt them or any other project type from applicable NEPA requirements at the Federal level or any other regulatory requirements at either the Federal or state level. Accordingly, implementation of a CWPPRA-derived MM or HR must first be authorized by the issuance of permits from the NOD and the issuance of permits and/or authorizations from several state agencies.

2.2.3. Trends

The NOD, Environmental Protection Agency (EPA), Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), Natural Resources Conservation Service (NRCS) and the State of Louisiana, as well as members of the public, were active participants in the CWPPRA plan solicitation, formulation, and design phases of the CWPPRA process. Recently, the NOD has sponsored CWPPRA projects as have other Federal agencies. Several CWPPRA marsh management and hydrologic restoration projects are in the final design phases, have been permitted and/or have been or soon will be implemented.

2.2.4. Cooperating Agencies

Preparation of the draft and final versions of this PHMEIS was a cooperative effort. NOD was the lead agency.

However, recognizing the roles of the several state and Federal agencies in the CWPPRA process and their mutual interests in the regulatory process, NOD invited the Environmental Protection Agency, National Marine Fisheries Service, the Natural Resources Conservation Service and the U. S. Fish and Wildlife Service, as well as the Louisiana Department of Natural Resources, Coastal Restoration Division, to participate as cooperating agencies. Coordination efforts are outlined in Chapter 6 and the agency representatives are identified in Chapter 7.

2.3. **Definitions and Concepts**

2.3.1. What is Marsh?

Marshes are wetlands visually dominated by grass-like plants. But, shallow open water areas are included in the concept of a marsh (Chabreck 1972). Open water areas are commonly referred to as ponds. Ponds need not be tidally influenced and may only temporarily retain water. Whether an area is more properly called a marsh with ponds or an open water (pond) area with fragmented marsh often hinges on points of view or management philosophy rather than any long-established scientific measure or common understanding. For example, the Louisiana Department of Natural Resources uses a data system that classifies an area as open water if there is less than 50 % vegetative cover.

Marshes are the product of the interaction of sunlight, temperature, water levels, water chemistry conditions, substrate compositions and elevations, and the degree of environmental variability (Gosselink, 1984). A marsh comprised of a mix of ponds and vegetated substrates usually has more associated plants and dependent animals than an equivalently sized area of just ponds or just grass.

Marsh and pond plants become established, grow and can be expected to sustain themselves (as well as their associated animal assemblages) wherever their life requisite requirements naturally occur or can be created and sustained. Management efforts very often are designed to intentionally induce and sustain life requisite conditions favoring one marsh plant association over another.

Marsh grasses that root in the soil and have plant parts that typically extend above the water are called *emergent species*. Pond plants that typically have parts that grow up to but not beyond the water surface are called *submerged aquatic plants*, or SAV for short.

2.3.2. What is Management?

Management is a deliberate undertaking to address an objective. Management can take many forms. The management form depends upon the purpose of the contemplated management effort and the prevailing environmental conditions. Doing nothing at all may be a practicable management decision. In a different situation action(s) may be required to control environmental factors to elicit the desired result.

2.3.3. What is Marsh Management?

No universally accepted definition of the management practice called *marsh management* (MM) exists. Chabreck (1968) noted that management was an action that should be undertaken to improve habitat for selected marsh dependent animal species (e.g. overwintering waterfowl, muskrat, nutria, alligators). Cahoon and Groat (1990) offered a definition that appeared in the U.S. Department of the Interior - Minerals Management Service's (MMS) document dealing with marsh management in Louisiana. Their definition is important because it was the first modern definition developed by all the interested parties **and** alluded to an extended application to include controlling wetland loss. That definition of MM is:

> *The use of structures to manipulate local hydrology for the purpose of reducing or reversing wetland loss and/or enhancing productivity of natural renewable resources.*

Clark and Lehto (1991) reviewed several definitions and in 1993, Good and Clark cite the following definition that is included in Title 43:I.721(L) La. Admin. Code:

> *A systematic development and control plan to improve and increase biological productivity, or to minimize land loss, or to enhance recreation.*

In August of 1994, the EPA defined structural marsh management as follows:

> *The use of spoil banks, levees and canal plugs to surround or partially surround a discrete parcel of tidally influenced marsh in combination with the use of water control structures to modify or control hydrology to various degrees for the purpose of protecting, restoring, or enhancing vegetated wetlands and/or their functions.*

2.3.4. Passive and Active Marsh Management

Active marsh management (AMM) and *passive marsh management* (PMM) forms have evolved. The kinds of management structures used, their location and operation describe more than define differences between passive and active management efforts.

AMM plans rely upon structures that can be reconfigured as needed, sometimes to mimic or override seasonal hydrologies or meteorological occurrences, to achieve management goal(s). AMM plans are typically proposed where it appears marsh loss cannot be otherwise slowed, stopped or reversed, changes in marsh condition cannot be affected by other means, or management goals can only be achieved by overriding prevailing and foreseeable hydrologic conditions. In effect, hydrologic conditions within the targeted marsh are intentionally created such that the rhythms and dynamics (and often water chemistry) of the surrounding marsh are significantly muted, and for periods, turned off. These conditions may even partly mimic some historic conditions but are today presumed necessary to achieve the management goal(s). Some would argue that because of how much the hydrology can be muted, this management strategy can be more impact intensive to biological and social functions and values associated with the targeted marsh.

Proposals to implement PMM plans occur less frequently. They correspond to efforts when attempts to achieve the desired management goal(s), typically water level retention, reduced erosion rates and enhanced growth of pond plants, nearly always rely upon the use of fixed-crest weirs, whether or not in association with levees. There is no intent to completely isolate the targeted marsh from the surrounding system. However, periods of little or no intercommunication between managed and unmanaged marshes can occur but typically last only so long as tidal water levels are below the fixed level of the weir crest. PMM plans generally rely upon structures whose configuration changes little if any over time to achieve management goal(s).

2.3.5. What is Hydrologic Restoration

The term *hydrologic restoration* (HR) is a fairly new term. It describes a management effort largely intent upon forestalling/preventing marsh loss or stopping/reversing it very early. Through the use of structures, conditions are established in targeted marsh areas that emulate some historic, often natural, hydrologic condition, thereby presumably reducing the influence of the current day erosional forces to levels when they were of little or no concern. This management option can encompass large areas

(e.g., sub-basin or watershed) and does not necessarily entail hydrologically isolating the targeted marsh.

2.3.6. Implications

Definitions of MM clearly emphasize the anticipated favorable effects on the vegetated landscape **or** organisms dependent upon marshes. In reality, some resources are often benefitted, but at the expense of others. As a result, managers and Federal and state regulatory and resource agency representatives typically spend a lot of effort revising or refining proposed management plans. Their efforts are intent upon reducing or eliminating adverse effects (Chabreck, 1994) without compromising the primary management goal(s).

MM and HR can be implemented to address private property and mineral rights. Site-specific hydrologic and marsh conditions often influence whether MM or HR is selected for implementation relative to other goals (e.g. addressing marsh losses, waterfowl habitat improvement). Regardless, to achieve their goals, HR and MM efforts could but need not use the exact same structures. However, their location and operation are usually different. Thus, simply knowing what structures would be installed is not definitive. An objectively written project description, inclusive of a structures operation plan, is usually needed to discern if a project is MM or HR.

Because of their similarities, MM and HR can be argued to be variants of each other. Proponents of this vision would say that they differ in degree and represent a continuum of sorts. Because of their differences, they can also be argued to be very different from one another. Proponents of this vision argue that HR and MM are alternative management approaches. The distinction can depend upon one's point of view.

Management structures typically effect a suite of hydrologically-influenced attributes, some by design some unavoidably. However, the best designed and operated application of management structures will be maximally effective only within a portion of the environmental variation that controls the viability of Louisiana's coastal marshes. Seasonal rainfall shortages or excesses, tropical weather systems and subsidence are factors some individual managers are powerless to slow, stop or reverse but significantly effect how much or how little their management efforts can be expected to achieve. Thus, the hydrologic effects of the structures selected for a given management effort seldom correspond perfectly with management needs. The difference can be the basis for the manager

contemplating what, if any, secondary interests can be addressed to what degree with what, if any, additional effort. The difference can also have associated social and economic implications as well as other biological consequences.

The NOD focuses on impacts and effects when it makes permit decisions. NOD appreciates that both MM and HR are designed to affect the hydrology of targeted areas in some predetermined and deliberate manner and degree. As such the effects and impacts can often be quite similar and in a few cases nearly identical. Accordingly, detailed analyses of additional information are often required to objectively distinguish differences....a prerequisite to making a fully informed permit decision. Thus, labeling a project MM or HR neither alters the manner in which it is evaluated nor predisposes its fate when submitted for permit consideration.

2.3.7. Erosion

Erosion is a process. It is characterized by the transport of and removal of marsh soils. The end of the process is the appearance of open water where once there was a marsh soil surface covered with vegetation (marsh loss). Changes in the composition of the marsh plants, or the outright loss of marsh plants without soil loss, may indicate erosion is occurring.

Shoreline erosion occurs when the marsh grasses and soils are exposed to the direct mechanical action of waves. Affected marsh often slumps before breaking off in chunks and falling into the water. Management to control shoreline erosion generally involves installing wave intercepting/disbursing structures.

2.3.8. Marsh loss

Several forms of marsh loss are recognized.

"Hot spot" marsh loss (Nyman et. al. 1993b) occurs when subsidence (i.e., sinking of the land) precedes, thus facilitating, water logging and/or saltwater intrusion. Chemical and physiological differences that arise in the soil stress the marsh plants. If the plants die and are not replaced, the soils are subject to accelerated loss from tidal and wind-induced wave action. If "hot spot" erosion occurs slowly enough, different vegetative assemblages, sometimes unlike those that originally existed, may appear and persist for a while. Management of "hot spots" tends to include efforts to retain destabilized soils longer and/or enhance the organic matter production/retention component of

the soil building process.

<u>Internal</u> <u>marsh</u> <u>break-up</u> (Nyman et. al. 1993) occurs when the action of the tides mobilizes the soils below the root zone.

2.3.9. New Marsh Erosion Insights

Recent field studies by Nyman et. al. (1993a, 1994) suggest that the natural process of water draining from the marsh due to winter storm tides may mobilize soils material from below the root zone. This is a very subtle phenomenon and was noted only by coincidence. The precise role in marsh loss remains to be quantitatively characterized.

Less a new scenario, and more a developing appreciation, the biological effects of nutria on marsh production, dynamics and vigor is gaining notoriety (Llewellyn and Shaffer 1993; Linscombe, 1993). Nutria grazing can create conditions that cause a marsh to erode that mimic the symptoms of erosion for completely different reasons (Foote and Johnson 1994).

Apparently, erosion of an otherwise healthy looking marsh can occur for reasons wholly unrelated to normal tidal action, prior management activities, or chemical (i.e., salinity) stress or anything else encompassed within the classic scenario. How generally applicable some of these other scenarios are throughout the Louisiana coastal zone (Nyman et. al. 1993d), or if there are still others to be discovered, has yet to be determined. What is apparent is that failure to appreciate their existence could lead an observer to an improper conclusion about what was causing the erosion {or an improper conclusion about the effectiveness of any contemplated or installed management effort (Nyman, Chabreck and Kinler 1993)}.

Thus, the reasons a marsh converts to open water (or does or does not respond to management according to expectations) may be in response to a few or a complex of factors, many, if not all, may be unique to the marsh in question.

2.3.10. Marsh Deterioration

Marsh deterioration is a subjective term. It describes how a marsh type has changed relative to the life requisite needs of some marsh dependent resource(s) and/or the goal(s) of a management effort.

The terms erosion and marsh deterioration have been used interchangeably. For example, some of the vegetative assemblages that may appear and disappear prior to the actual loss of the marsh soil have been referred to as eroded as well as deteriorated marshes. They are not used

interchangeably in this PHMEIS.

2.3.11. Synthesis

In 1968, Chabreck described MM as the use of certain management structures to achieve specific goals relative to marsh dependent resources. From about 1977 until about 1990, the term marsh management was used progressively more often to also describe actions intent upon affecting the factors that, when managed, were thought to contribute to slowing, halting or reversing marsh losses. Thus, the term has become less precise in its meaning, which is probably why the term now means different things to different people.

Chabreck (1994, pg 45) has perhaps captured the essence of the evolution and, recalling his earlier perspective, restated the current condition and set the tone for the future, as evidenced in the following quotation:

> *"Marsh management is a broad term and is often used to describe activities other than management of marshes. Programs designed to manage waterfowl, fur animals, alligators, marine fisheries, freshwater fisheries, crawfish, cattle and even mosquitos have been described as marsh management. However, the term, 'marsh management', when used without modifiers, should describe the manipulation of a marsh and associated water bodies in a manner that enhances growth of submergent and emergent vascular plants. Management of a marsh for resources should be defined as management for those resources and not marsh."*

2.3.12. Hydrologic Management

Hydrologic management (HM) is a term created and used in this PHMEIS. It refers specifically to projects that attempt to achieve goals (e.g. marsh restoration, waterfowl habitat improvement, protection of property rights) by using man-made and/or natural landscape features to:

a) intentionally affect selected attributes of the hydrology of surface waters, yet
b) maintain some amount of two-way surface water exchange between a managed area and adjacent areas.

The NOD coined this term to more precisely limit the scope of this HMEIS to MM and HR. For example, sediment or fresh water diversion projects or impoundment management projects cannot be HM projects because the operation, design or selected controlling structure(s) make no provision or intent for two way exchange. Using HM also allows us to focus more on programmatic impacts and effects associated

with the use of the same sorts of structures. Thus, determining whether a project is more properly labeled for permit purposes as a MM or HR project is secondary to an analysis of project particulars usually only made available when analyses of individual projects are initiated.

2.3.13. Apparent and Actual Marsh Gain

These are also two terms coined by NOD for use in this PHMEIS, *apparent marsh gain* and *actual marsh gain*.

Actual marsh gain is envisioned as the theoretical goal or endpoint of marsh restoration efforts. Actual marsh gain would occur when the elevation of formerly eroded marsh soils should or does support the sustained growth of emergent marsh plants characteristic of nearby unmanaged marshes even if management efforts were suspended for a growing season or discontinued. In other words, the ecological functions and values of native and management-regenerated marshes would not be appreciably different.

Apparent marsh gain is defined as any of the marsh soil/marsh plant regeneration conditions a hydrologically managed marsh may evidence before actual marsh gain is achieved. Stages of apparent marsh gain could be goals of HM efforts. However, the ecological functions and values of native and any such management-dependent marsh plant assemblage would be demonstrably different.

3.0. *ALTERNATIVES*

The **proposed action** is the future issuance of permits by NOD that would authorize the installation, operation and maintenance of structures pursuant to hydrologically managing Louisiana coastal marshes.

Consideration of the **no-action** alternative is required by NEPA. Literally, that equates to NOD denying every future application for a permit requesting authorization to perform activities or to install/operate/maintain structures necessary to carry out hydrologic management {HM = marsh management - MM (active and passive forms) and hydrologic restoration - HR} efforts beyond those already permitted. Conceptually, that equates to a determination that future proposals would either be contrary to the public interest or would fail to comply with provisions of the Clean Water Act or other applicable laws. It does not mean revoking or suspending existing permits.

3.1. No Action (Future Without Additional HM)

The effects of this alternative are the reasonably foreseeable consequences of the continued operation and maintenance of projects that have been completely implemented, partially implemented and/or that are implementable. Abandonment of a completely implemented project is also a possibility but is not explicitly addressed.

For the purposes of this PHMEIS permit applications received and permitted by the New Orleans District from 1977 through February 1996 and partially or fully implemented by the permittee for activities related to HM served as the data base. Excluded from the data base were permitted projects for which no work had been done and the permit had expired.

3.2. Proposed Action (Future With Additional HM)

NOD has concluded that the proper scope of alternatives for the proposed action considered in this PHMEIS is the HM efforts known as MM and HR. Thus, the effects of this alternative are the reasonably foreseeable consequences of the future installation, operation and maintenance of candidate CWPPRA HM projects.

3.2.1. Assumptions About Source, Number and General Concept of Candidate CWPPRA HM Projects

Several commentors, including some of our cooperating agencies, urged NOD to use the MM permit data base to

project future permit issuances as an alternative to using candidate CWPPRA HM projects as the most likely future (see Appendix S).

There are several problems with using the historic permit data base. The data base is not extensive. Only 71 permits are presumed to be partially or fully implemented since 1977. That data base is neither the product of nor was it intended to be reflective of a wide public input process. Much more importantly, issued permits do not occur in equal numbers across all years, basins, regions, included marsh cover types and management purposes. To infer permit locations, included marsh types, sizes, purposes, issuance and implementation rates and then to attempt to infer impacts from such a data creation effort would require formulating and relying upon some tenuous assumptions.

On the other hand there are the candidate CWPPRA HM projects. Culmination of the CWPPRA process in the funding and implementation of several CWPPRA-derived HM plans is, in the opinion of NOD, explicit evidence of a commitment by agencies of the Federal government and the State of Louisiana, both cost sharing partners, with the blessing of some members of the general public, that MM and HR have a future in coastal Louisiana. NOD does not endorse or discount that perception.

Some commentors on the draft PHMEIS urged NOD to address in detail the impacts associated with all the CWPPRA project types because they have as their common goal slowing, stopping or reversing marsh losses. The general relationship between all the CWPPRA management alternatives was presented in the Louisiana Coastal Wetlands Restoration Plan: Main Report and Environmental Impact Statement (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). Thus, NOD's PHMEIS focuses only on the candidate CWPPRA HM projects, to include MM and HR. It was never NOD's intent or prerogative to re-write the entire CWPPRA programmatic EIS.

Other commentors urged us not to include HR at all. However, all forms of HM (i.e., AMM, PMM, HR) rely upon essentially the same set of management structures, each installed in similar fashion, but often located and/or operated in only slightly different ways. Intuitively, then they must also have similar, if not sometimes nearly identical, consequences. What's more, these two forms of HM would require the same Federal permits and the factors considered in the corresponding permit evaluations would be nearly identical.

Some commentors suggested that considering the entire CWPPRA MM and HR pool of projects overstates the future condition. However, there are several reasons why we respectfully believe our approach is appropriate.

Several CWPPRA HM projects have already come before NOD for permit consideration. Collectively, those projects encompass well in excess of 100,000 acres.

Unlike the permit data base, CWPPRA projects were developed from an intensive series of public meetings in which the general public, landowners and local officials statewide were asked to suggest site-specific solutions to marsh loss problems. This pool of projects represents the HM projects that people had already planned plus others that the participants felt might be viable in the future.

Furthermore, CWPPRA is not restrictive. Nothing prevents an entity from applying for a permit for a CWPPRA-sanctioned project through non-CWPPRA channels, and then appealing for funding under CWPPRA at a later date (as is the case with some projects on the 1st CWPPRA Priority Project List). Accordingly, NOD has assumed that the CWPPRA pool of MM and HR projects is the most reasonable projection of the maximum number (by basin), longevity (20 years) and location of such projects (see basin maps in CWPRRA appendices).

Additionally, the CWPPRA basin plans, appendixes to the CWPPRA programmatic EIS, provide footprints for every candidate HM project as well as show spatial associations between projects, project acreages, identify included marsh types, stipulate the particular marsh loss problem being addressed, and suggest the kind, number and operation of structures.

Finally, the list represents the most comprehensive "wish list" of candidate HM projects. Accordingly, it provided us with a means to obtain a perspective on impacts relevant to the permit decision making process. The instantaneous construction of all CWPPRA MM and HR projects is regarded as a "worst case" scenario. Adopting a worst case scenario is provided for under the Council of Environmental Quality's regulations for implementing the procedural provision of the National Environmental Policy Act (40 CFR Parts 1500-1508).

3.2.2. Assumption About Candidate CWPPRA HM Projects Design Details

Many CWPPRA HM projects are conceptual. Nonetheless, comments from several cooperating agencies clearly indicate a continuing interest in candidate CWPPRA HM projects throughout the Louisiana coastal zone. And, for those

projects, only the final details about the number, kind, location and operational program of any installed structures would have to be determined during the evaluation of each individual permit request, which often involves an interagency inspection and follow-up evaluation of the project area. For most of the others, preliminary information about the kind, number and operational schemes of candidate structures is available and, for quite a few, is well enough developed to proceed to permit application submittal. However, the design and operational details of any plan's structures are preliminarily determined immediately prior to submitting a permit application and finalized when the required permit is issued.

The potential number of combinations possible when considering the number, kind, location and operational schemes of candidate structures is too large to comfortably handle even within a programmatic context. Until project designs are finalized, projections of project specific impacts have been addressed collectively and in a conceptual context based upon entries made in tables profiling previously permitted MM (1977-1996) and candidate CWPPRA MM and HR projects.

3.2.3. Passive Marsh Management (PMM)

PMM will be addressed in this programmatic EIS but in a somewhat different context than either HR or MM. Passive management, where a fixed-crest weir (crest elevation about six inches below the marsh surface) is used to control the hydrology of a semi-impounded area, is rapidly becoming a relict form of MM and is not included as a project type in CWPPRA. (NOTE: Low-sill fixed-crest weirs [crest elevation typically several feet below the water surface] are installed to reduce tidal scour in man-made waterways). Thus, the "future with" condition will focus on characterizing the effects existing passive management projects impart into the foreseeable future rather than characterizing effects of any additional passive management projects. This also means that any future requests for semi-impoundment management using fixed-crest weirs would not be covered by this document.

3.2.4. Assumption About Rate of Project Implementation

In contrast to some arbitrarily phased implementation rate, NOD assumes that all candidate CWPPRA HM projects will be installed all at once and immediately. Clearly, this is merely a simplifying assumption. However, the MM and HR projects included in the CWPPRA basin plans represent incremental, typically site specific but nonetheless measurable efforts (at least qualitatively) to arrest

coastal erosion and are presumed by CWPPRA to be viable candidate projects. Even if only some candidate CWPPRA HM projects are eventually implemented, the associated impacts would be less relative to the total potential impacts likely to result if all CWPPRA HM projects were eventually implemented.

Conceptually, by assuming immediate and total implementation, we believe we minimize the potential to overestimate total effects. We feel this way because we do not account for incremental impacts associated with any gradual implementations. We expect that impacts associated with implementation of each project would be accounted for during the permit evaluation process.

4.0. *HISTORIC, SCIENTIFIC AND SOCIOECONOMIC SETTINGS AND PROFILES OF SIGNIFICANT ATTRIBUTES*

A Perspective is presented first (4.1.). Presented next is a summary of Marsh Management (MM) in Louisiana (4.2.). Following that is a discussion of the Significant Attributes of Louisiana's Coastal Marshes (4.3.), which includes an overview of the climate and geology of coastal Louisiana. Section 4.4. examines Marsh (Land) Loss. Section 4.5. concludes this section of the F-PHMEIS with reference to how the cooperating agencies deal with HM actions.

Brief profiles of the four Louisiana coastal marsh types are presented as Appendix A. Appendix B is a narrative comparison of many of the water control structures used for managing Louisiana's coastal wetlands.

4.1. Perspective

Louisiana's coastal marshes have for centuries been viewed by the original native inhabitants as a rich place to fish, hunt, harvest furs and oysters. Those exact same attributes came to define the life styles of some (Ensminger, 1989; Davis 1993b) and became the foundation of the culture for others (Davis 1993b), including those who later moved to Louisiana and came to reside in or near and derive some or all of their livelihood from the coastal marshes. Since the early 1800's, marshes have been leveed and pumped (Miller 1956), rivers have been channelized and leveed to redirect flows to protect life and property and often to foster agricultural endeavors (Viosca 1928). Beginning in about the middle of the 1800's, private as well as commercial maritime and port interests began to expand in response to increasing agricultural production. Transportation by water was highly desirable. Because of their expansiveness, coastal marshes were perceived to be a physical obstruction. Thus, there was little objection from any quarter to their being dredged to create navigable waterways to foster economic development. Construction of what would ultimately become an extensive web of surface waterways began. The waterways were built by private, commercial and public entities to interconnect emerging points of economic activity throughout the entire coastal wetland complex and/or foster the rise of new economic activities. The vision was so clear and the initiative was so successful that portions of the web begun in the mid-1800's have been subsequently upgraded and incorporated into today's Gulf Intracoastal Waterway.

Shortly after the turn of the 20th century, petroleum and mineral extraction operations began a nearly 50-year run of

unprecedented growth. During the period from the 1950's to the late 1980's, much of that growth was in coastal wetlands. Fundamental to the growth of those operations, there occurred a new spurt of dredging of coastal marshes. Not only were miles of new surface waterways excavated to facilitate the movement of vessels, but miles upon miles of marsh were also excavated to install pipelines to transport the extracted petroleum and minerals to pump stations and processing and shipment centers. Additionally, existing natural and manmade waterways hydrologically connected to the Gulf of Mexico were repetitively widened and deepened and new waterways were also excavated to accommodate the distribution and delivery of the extracted petroleum and mineral resources as well to accommodate the routine movement of ocean-going vessels to support emerging offshore petroleum and mineral extraction operations. Again, there was little objection to this additional activity because the coastal marshes were unquestionably vast, were still perceived as a physical obstruction and huge sums of money were involved at private as well as public levels.

The network of manmade waterways and channelized natural waterways that exists today was both the stimulus for and response to the development of what is today a highly valued infrastructure in Louisiana's coastal wetlands. Social perceptions and attributes have changed, some willingly over the years, some not.

4.2. **Marsh Management (MM) in Louisiana**

4.2.1. Historic Reasons to Manage Marshes

During the first quarter of this century, the commercial harvest of furbearers and waterfowl was extremely motivating (Ensminger, 1989). The market economics sustained by commercial waterfowl hunting played an undeniably influential role in fostering the management of marsh through water level control (Ensminger, 1989). Thus, wildlife managers early on developed techniques, structures and procedures to improve marsh conditions for furbearer production and overwintering waterfowl (Chabreck 1960, 1968, 1971, 1976; Jemison and Chabreck 1962; Chabreck, Yancey and McNease 1974). Managers pursued their goal primarily by dampening selected attributes of the hydrology of the targeted marsh (Broussard, Undated).

In the early 1940's, species-oriented management of Louisiana's coastal marshes became more extensive and linked to the use of water control structures to control water levels (Broussard, Undated; Cahoon and Groat, 1990).

During the 1950's and 1960's, oil and gas exploration and extraction efforts escalated. Mississippi and Atchafalaya Rivers flood control projects had by then been completed for several decades. Correlated with these events, marsh loss rates accelerated to disturbing levels (Gagliano et al. 1981); Turner, 1987; Dunbar, Britsch and Kemp 1990, 1992; Britsch and Kemp 1990) and an added concern developed over mineral rights reverting to the state if marsh eroded (Wilkins and Wascom 1989). Collectively, the concerns catalyzed design and operational refinements of management approaches, structures and operational considerations and fostered a search for solutions to slow, stop or reverse the conversion of emergent marsh to open water (Governors's Coastal Restoration Technical Committee Report 1988; Clark and Lehto 1991, Talbot and Tuttle 1992).

With previous species-oriented management successes as a guide, wildlife and marsh managers were positioned to assist in the initial efforts to fight marsh loss and they did so by offering a solution that was strongly influenced by their special expertise.

Even these more recent MM efforts were typically undertaken by landowners or leaseholders intent upon capturing the greater recreational and economic potentialities of hunting, trapping and fishing for marsh dependent animal species (Chabreck 1960, Chabreck 1994, Talbot and Tuttle 1992). The prevailing perception was that if marsh-dependent species benefitted then surely the marsh in general also was benefitted. By 1967, about 100,000 hectares (247,000 acres) of Louisiana's coastal wetlands were already under some form of management.

In the late 1970's, the U.S. Department of Agriculture - Soil Conservation Service (now the Natural Resource Conservation Service - NRCS) mated the variable-crest weir with a culvert and flapgates. This was a landmark event that significantly expanded MM capabilities. When used to control water levels in hydrologically discrete areas, managers created the capability to induce and sustain artificially controlled environments. The hydrologic conditions within a managed area could be manipulated pretty much independently of the seasonal water level and chemistry rhythms and dynamics of the estuary. With the capability to create controlled environments, managers could then indirectly influence how much of what kinds of plant species could be induced to grow in the managed area. They reasoned that water levels could be drawn down to and subsequently maintained at specified levels relative to the level of the marsh surface or pond bottoms by configuring water control structures to only allow the movement of water from managed areas through properly configured water control structures

when favorable wind and tidal conditions occurred, typically in late winter through early summer. It only took one or two successful draw downs for any manager to conclude that marsh plants, especially the highly desirable submerged aquatic species (Chamberlain 1959), responded well to water level reduction and control.

With the potential to affect how much and what kind of marsh plant communities occurred within managed areas, it follows, from ecological theory (Smith 1980), that managers could influence (indirectly) the collection of animal species associated with managed areas. This had obvious economic implications regarding waterfowl and furbearers. Since that time, managers have and often do elect to enhance economic or recreational interests through MM (NOD's permit data base), sometimes with as much vigor as their effort to affect marsh loss rates (NOD's permit data base).

4.2.2. An Additional Reason

During the 1970's and 1980's, the magnitude of the already on-going marsh loss problem was quantified and was prominent enough to capture the attention of the Louisiana Department of Natural Resources (DNR) and the NRCS, and the US Department of the Interior - Fish and Wildlife Service (FWS). By the mid-1980's, the DNR and NRCS had begun to encourage MM planning activities (Spicer, Clark and demond 1986) as a way to stem marsh losses. By 1986 nearly 600,000 acres of Louisiana's 2.5 million acres of coastal marshes were under some form of active management (Spicer, Clark and demond, 1986).

Their advocacy during that time represented the vanguard of the evolving perceptions and sophistication of MM and reflected the following assumptions: 1) Louisiana's coastal marshes have been lost, still are being lost and will continue to be lost at something approaching recent, rapid rates; 2) these losses threaten the ecology, economy and culture of Louisiana; 3) man's past activities have caused some of the marsh erosion problem; thus, 4) man has an obligation to intervene to stem erosion rates, where practicable. Their position was appealing. It was founded upon and embraced the relatively unchallenged and reasonably well demonstrated potentialities of MM to successfully affect the population dynamics of traditionally targeted animal species by controlling and modifying their habitat conditions. Their expectation was that variations on that successful theme could lead to invigorating vegetation on native, uneroded soils as well as encourage the revegetation of exposable, eroded marsh substrates, thereby combating the combined effects of subsidence and sea level rise by enhancing the growth rate and vigor of marsh plants and

stimulating root zone growth rates. Furthermore, their expectation had a recognized theoretical basis (Linde 1969). Thus, they reasoned that their approach represented nothing more than a new and novel application of an older, proven technology. Their approach has become the conceptual model for modern MM.

However, others remained skeptical. The fundamental operative mechanism(s) and the potential wide-scale applicabilities of the emerging concept had yet to be independently and conclusively demonstrated from either previously implemented actions or on-going field applications. Still others were uneasy because of the perceived social and economic implications.

Nonetheless, applications received by NOD to manage marshes escalated during the 1980's (Appendix C). The escalation occurred partly in response to positions taken by DNR and NRCS but also because MM was appreciated by land owners and leaseholders to be an attractive, site-specific solution that comprehensively and in a complimentary manner could address a number of biological concerns (Broussard, Undated) or did address one of several other social, economic, legal or administrative problems linked, directly or indirectly, to the amount or condition of the marsh (Wilkins and Wascom 1989).

As of February 1996, some 495,000 acres (216,000 hectares) have been permitted for some form of management. During the last 10 years, the full potentials and capabilities of MM relative to arresting marsh losses and the details that define all the broader consequences have not been resolved.

Expectations are apparently different from demonstrable successes. Based upon findings reported by Groat and Cahoon (1990) and NOD's permit data base (relative to monitoring), documented instances where management efforts demonstrably forestalled, slowed, stopped or reversed actual marsh losses are rare.

Largely based upon anecdotal evidence, as well as professional insight, the debate between proponents and opponents continues. Speculation continues about scientific, social and economic merits of MM as a comprehensive and complimentary approach to addressing most marsh issues.

Publication of Cahoon and Groat's (1990) study of MM was one response to that continuing debate. To the surprise of some proponents as well as some opponents of MM, that study didn't confirm, expand or diminish the utility of MM. Instead it provided partial answers to a limited set of

questions about the biological potentialities and shortfalls of MM.

The advent of the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) was also a landmark event. It is a forum to address in greater detail the biological implications, potentialities and effects of MM (as one of several other approaches to stemming marsh losses) and design and fund plans that reflect the broader social and economic implications of managing marshes (Steller et al. 1993). As a result, a form of managing marshes, hydrologic restoration (HR), was formally recognized (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993).

4.2.3. Why Manage Marshes Into the Future

The ability to reap some of the more traditional social and economic values associated with marshes, to included marsh dependent biological resources, has been for years a highly motivating reason to manage marshes. It is likely to remain a highly motivating reason to manage marshes during the next 20 years, and beyond.

Consider also that landowners that create and preserve a physical boundary around their property can generally preserve their mineral rights despite subsequent marsh losses. Such an effort need not successfully deter marsh loss or improve dependent species' habitats for the landowner to retain the mineral rights and impede the state's ability to claim ownership of eroded areas and associated minerals (Wilkins and Wascom 1989).

Additionally, CWPPRA suggests that MM is seemingly perceived ever more frequently by all involved as one of several defensive approaches to addressing coastal erosion (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993) and, as Chabreck (1994) noted, inherently address a multitude of concerns. Perhaps that's why most CWPPRA MM plans feature measures to address marsh loss, subordinating other interests. Yet, even some CWPPRA plans feature measures intended to improve habitat conditions for selected animal species if the situation calls for such action.

Given the momentum of CWPPRA, NOD expects MM and HR plans, featuring measures anticipated to slow, stop or reverse the loss rate of native marsh soils and plants, to be the most frequently stated reason for wanting to perform MM that will come under review for Federal permits. This programmatic EIS reflects that expectation.

4.3. **Significant Attributes of Louisiana's Coastal Marshes**

"Little is known about many basic aspects of wetlands."
Payne (1992, page 4).

4.3.1. Prologue

Management is one of many historic and on-going activities attempting to induce/respond to changes in the dynamic system that is Louisiana's coastal marshes. It has been an on-going activity in one form or another for decades. Before the totality of the physico-chemical, biological, socioeconomic and cultural consequences of those actions can be fully appreciated, the structure and function of the marsh system within which the management activity occurs should be appreciated as much as possible.

Louisiana's coastal marshes can be visualized as consisting of many components (e.g., sediments, grass, fishermen). Each component, called a significant attribute, has its own identity. But, their interdependencies define the structure and function of coastal marshes (see also Appendixes A, B, E, F and R). Accordingly, when one significant attribute is impacted, either intentionally or unintentionally, by a HM action, the effects can potentially be evidenced throughout the marsh system. Thus, knowing what significant attributes are interrelated is useful for:

1) understanding why management efforts are perceived as they are; and,

2) predicting what significant attributes that comprise Louisiana's coastal marshes might be expected to change in response to management.

However, precisely predicting how much interrelated significant attributes can be expected to change in response to HM efforts requires knowing a great deal about what factors control the myriad interrelationships.

MM has been, and MM and HR are and will continue to be, fundamentally involved with affecting water in some way (see Appendix B) to achieve some greater purpose.

As early marsh managers learned, selectively and differentially controlling several hydrologically-influenced attribute(s) of a marsh is typically required to set in motion a chain of events leading to the desired management outcome. For example, a traditional waterfowl or furbearer manager may have had to start by installing or upgrading a set of water control structures simply to acquire the potential to induce (and sustain) different degrees of

change in the salinity (and/or depth of flooding, duration of flooding, etc.) of a targeted marsh. Once the structures were operational, the manager would proceed to induce a great enough change in some predetermined suite of hydrologically-influenced attributes. If successful, then the manager had to sustain those artificially created abiotic conditions long enough for the anticipated and generally corresponding biotic change of the marsh plant community component(s) to occur. Only after the manager observed the marsh plant community responding according to expectations was it possible to gain some sense of how well the targeted animal species could be expected to respond to that year's management effort. And that expectation would reflect a comparison of the managed area's current condition relative to efforts from previous years and/or what the corresponding waterfowl, furbearer, or alligator population and harvest would have been without management.

Like their predecessors, modern managers of marshes still strive to selectively and differentially control several hydrologically-influenced attribute(s) of a marsh at the same time. And, managers still strive to set in motion a chain of events leading to the desired management outcome. However, success is gauged ever more frequently by whether the management effort forestalled the loss of, or how much it was able to slow, stop or reverse the loss of, native marsh soils and plants. The assumption is that the net effect of such efforts is beneficial on the functions and values of managed marshes that exhibit increased emergent and/or submerged aquatic plant biomass and coverage. A corollary assumption is that marsh-dependent animal species traditionally targeted for management are also unavoidably benefitted, although maybe not quite as much.

4.3.2. Overview of the Geologic, Physical, Meteorological and Chemical Environments of Louisiana's Coastal Marshes

Louisiana's coastal marshes have been, are and will continue to be the product of the relationship between climate, ocean depth and coastal topography. Like their counterparts throughout the world, Louisiana's coastal marshes acquire their requisite resources from the atmosphere, soil and/or water. Thus, the location and extent of Louisiana's coastal marshes as they occur today, as well as the how far they may have extended "seaward" or have retreated landward over time, are conclusive evidence that favorable marsh plant growth conditions are not static in space or time.

Today, Louisiana's coastal marshes are testimony to the influences of global-scale forces that prevailed nearly two million years ago. Ocean depths successively rose and fell

as much as 400 to 500 feet in response to alternating periods of warm and cold climates. Continental land surfaces eroded at differing rates. Great and little rivers appeared and disappeared, their loads of sediments being deposited in the relatively lower energy environment that occurred at the then-existing interface between ocean and land. Over time, the nearshore sea floor elevation rose toward the water surface. The most recent cycle of fall and rise began about 80,000 years ago.

Within the last 5,000 years, the mouth of the Mississippi River has relocated several times. Wherever the river's mouth was located, sediments were deposited creating a delta. Each delta was laid down over a period of several hundred years. As the surface elevation of the deposited sediments of an accreting delta rose to meet or break through the water surface, conditions became progressively more conducive to the appearance of marshes. Those marshes were the precursors of today's Louisiana delta marshes.

When more westerly deltas were being created, finer-grained river-origin sediments were translocated more westerly. They intermingled with larger-grained Gulf-origin sediments, and accumulated in the lower energy, shallower Gulf waters seaward of the Pleistocene terrace. When the river shifted easterly, previously deposited sediments were remobilized by the Gulf. Finer materials were carried away. The remaining larger grained sediment components were redistributed and "windrowed" into beach front ridges. Because the Mississippi River relocated itself several times, a series of roughly parallel beach front ridges, called cheniers, arose along Louisiana's western Gulf shoreline. These features are the basis for the name of the Chenier Region.

In accreting areas, substrate elevations rise faster than water levels change and substrates compact or slide down the slope of the continental shelf. Wave and tidal action can redistribute some of the deposited sediments many times before they are more or less stabilized through compaction/consolidation.

When substrates are overlain with shallow waters, or are exposable or exposed during some portion of the tidal cycle, conditions become conducive to supporting the growth of submerged aquatic vegetation or marsh plants. In eroding areas, the soil elevation/water level relationship becomes progressively unfavorable as soil elevations move downward and away from water levels (Day and Templet, 1989).

Never has the mouth of the Mississippi River exactly reoccupied a former position. However, the relocations of the river's mouth all occurred within an approximately 200-

mile wide stretch of the Louisiana portion of the Gulf coast. Accordingly, several successively newer deltas overlay portions of earlier deltas. The Atchafalaya and active Mississippi River deltas are the two newest deltas. The Barataria, Terrebonne, Vermilion, and Pontchartrain Basins generally correspond with different deltas. Those deltas increase with age respectively and are the basis for the names of the associated Delta Basins.

These deltas are all underlain by the Louisiana portion of the continental shelf as it descended into the Gulf. The shelf descends more steeply under Delta marshes than under Chenier marshes. What's more, depth to the shelf increases as one nears the Gulf shoreline. Additionally, old, buried river valleys that ran from the upland to the Gulf have filled in over the centuries. Kuecher (1995) suggests that subsurface geomorphologic attributes can influence marsh soil elevations, on basin as well as sub-basin scales. Soil differences were also noted a sub-basin and smaller spatial scales (see Appendix A).

The global climate has not changed very dramatically over the last several thousand years but we have been and still are in a relatively warm phase. The level of the sea has been rising measurably (about five hundredths of an inch per year- Penland and Ramsey, 1990), and is expected to continue to do so. How much it will rise and the consequences at a regional, basin or project site scale can't be predicted in absolute terms.

In many of the Terrebonne Parish marshes the elevation of the marsh soil surface moves downward and away from the sea at a rate of about one-half inch per year, a very high rate for coastal Louisiana marshes (Penland and Ramsey 1990). But for the sediment replenishment provided by the Atchafalaya River, the marshes that surround Vermilion and the Cote Blanche Bays would exhibit the highest rate (Penland and Ramsey 1990). Elevation of marsh surfaces to the east and to the west are also declining relative to sea level but at progressively slower rates the more east or west one goes from the Terrebonne Parish marshes (Penland and Ramsey 1990).

The sun and moon impart identifiable signatures on the tidal dynamics along Louisiana's coast and in Louisiana's coastal marshes. Those effects are measured in terms of predictably reoccurring approximately monthly cycles and more often in inches of water level change rather than feet.

In marshes nearer the Gulf, regular, daily (and in some cases twice daily) tidal changes flush the soil profile (Gosselink 1984; Gosselink, Cordes and Parsons 1979). As

distance inland from the Gulf and tidal passes increases, tidal effects diminish, with marsh surface water levels responding more to the effects of winds and upstream runoff.

In the Delta the differences are dramatic. Delta marshes along the coast are flooded on average for about 12 hours each day whereas flooding duration increases to as much as four to five days in Delta freshwater marshes.

Seasonal climatic differences are also influential. Prevailing wind direction and speed (Barlow 1956) and barometric pressure can result in flooding durations near 70 to 80 percent of the time in mashes closer to the Gulf in September and October (Gosselink 1984; Gosselink, Cordes and Parsons 1979). The passage of winter cold fronts is preceded by increasing winds from the south which can cause water levels to rise several inches. After a front passes, typically accompanied by rain, west and/or north winds "blow" water out of the marsh, with the potential to reduce water levels by a much as two feet. A reduced water level condition may persist for several days because of the prevailing high barometric pressure and winds associated with the prevailing weather system. As atmospheric pressures and winds equilibrate, water levels again return to normal in advance of the next cold front passage. In contrast, from mid-summer (just after the marshes typically reach their growth peak) through fall, a hurricane (extremely high wind, intensive rainfall, very low barometric pressure) over a period of several days can force up to 10 to 15 feet of water into those same marshes.

The duration and timing of precipitation, seasonal and local differences in temperature patterns, seasonal and daily changes in barometric pressure, wind speed and wind direction are all influential components of the climate that influence Louisiana's coastal wetlands (Gosselink, et al. 1979). Just like the effect of the sun and moon impart identifiable and separate signatures on tidal dynamics, these climatic components also exert separable, identifiable influences on water levels. For example, monthly average air temperatures exhibit the same yearly pattern throughout coastal Louisiana's marshes but are a degree or so warmer in the more southern coastal marshes and also tend to be warmer in the more western marshes. Rainfall occurs throughout the year in coastal Louisiana marshes. Maximum monthly amounts fall in July as the result of localized thunderstorms. Appreciably lesser amounts fall in October. During winter, rainfall usually accompanies frontal passage. Nonetheless, the average yearly total of nearly 60 inches per year occurs in the more eastern marshes while the western marshes receive about 50 inches per year. Wind speeds are generally lower and from the south in summer. During the winter the

prevailing wind direction is more northerly and wind speeds are measurably higher on average.

The distribution of Louisiana's coastal marsh types has been described relative to surface water salinity regimes (Sasser 1977, see also Appendix A). Average salinity and the range of salinities generally decrease as the distance inland from the Gulf shoreline increases. The plants that comprise the coastal marshes are not equally able to contend with the entire range of salinities that occur throughout coastal Louisiana. Instead, plants with similar salinity tolerances grow in association with one another. The associations are so distinctive four marsh types have been identified and described relative to prevailing salinity regimes. The four types occur in bands that are aligned roughly parallel with the Gulf shoreline (Chabreck 1972, Chabreck and Linscombe 1982). The most salt tolerant marshes occur at the Gulf of Mexico shoreline. Inland from there, tolerance to salinity decreases. However, variation on sub-basin scales were also noted (see Appendix A).

Regardless of marsh type, salinity, in combination with low or no oxygen soil conditions in the root zone, can, as the result of chemical reactions, affect/immobilize plant nutrients (Pezeshki and DeLaune 1990; Day et al. 1989), affect plant physiology (Pezeshki, DeLaune 1987; Pezeshki et al. 1989) and growth patterns (Pezeshki and DeLaune 1990; Pezeshki, Matthews and DeLaune 1990), and, if conditions persist, can accentuate the build-up of compounds toxic to plant growth (Pezeshki, DeLaune and Pan 1991; Mendelssohn, McKee and Patrick 1981). Prolongation of such conditions can lead to the death of many if not all of the affected marsh plants (Koch and Mendelssohn 1989).

Many different marsh soils arose in response to past processes occurring along several different time and spatial scales (Gosselink, Cortes and Parson 1979; Gosselink 1984). Organic and mineral (i.e., sand, silts, clays) content are two easily measured attributes of soils with which the presence or absence of a very common marsh grass (Pezeshki et al. 1989) and plant biomass in brackish (Nyman et al. 1993) and saline marshes (DeLaune and Pezeshki (1988) can be correlated. Additionally, many fresh marsh plant species require less mineral sediment inputs than do brackish or saline marsh plants (Nyman et al. 1993c). Thus, marsh soils should not be ignored as something potentially influencing marsh plant distributions and production (see also Appendix A).

Vegetated marsh soils are more resistive to erosion than the same soils in an unvegetated condition. That is evidence that marsh vegetation can affect attributes of marsh soils.

Reciprocal relationships between marsh soils, marsh plants and soil composition and accretion (Nyman et al. 1993f), and marsh dependent animals have also been demonstrated. For example, burrowing animals create avenues for water and oxygen to more quickly exchange within the root zone (Day et al. 1989; Gosselink 1984). Castings made by burrowing animals become large grained sediment depositions. Marsh plants, and dried algae mats, are irregularities on the marsh surface that slow water movements, enhancing sediment settling. Nutria can denude areas (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor et al. 1992), exposing the fragile marsh surface to erosive forces. Nutria burrows can undermine an area so thoroughly that the marsh surface caves in and washes away (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor et al. 1992).

4.3.3. An Overview of the Written Record

Basic information about Louisiana's coastal marshes can be derived from several sources. For example, Brupbacher et al. (1973) examined and reported on the chemical properties of the soils of Louisiana's coastal marshes. Chabreck (1972) gave us an authoritative "snap-shot" profile of the vegetation, soil and water characteristics of Louisiana's coastal marshes. Sasser (1977) reported on the correlation between tidal flooding and the distribution of Louisiana's marsh plants in Delta marshes. A text book treatment of general coastal sedimentary environments, with reference to Louisiana, is presented in Davis (1978). Touchet (1994) discusses the formation of soils in coastal Louisiana. The NRCS has soil surveys for all coastal parishes (some currently in print and others being updated) that contain more detailed information. No written record exists and managers are unable to detail from experience how marshes will comprehensively respond to HR. And, unfortunately, insights acquired by managers from years of working with individual marshes are not always reflected well if at all in the documented record.

How some components of Louisiana's coastal marshes respond to MM have received far less attention than others (Day et al. 1989). Of the components that have received attention and been documented, some have been studied in more breadth, detail and with more rigor than others.

The factors that influence the rates and interactions of marsh processes and the roles of the participating organisms have been conceptualized. For example, the bacteria, fungi, algae, phytoplankton, zooplankton, and protozoans associated with Louisiana's coastal marshes are components of Louisiana's coastal ecosystems that have been little studied. They are absolutely essential biological

intermediaries in the processing and repackaging of nutrients and organic matter for use by other marsh/estuarine organisms (Day et al. 1989, DeLaune 1995; Myers 1995). Their roles are characterized by measuring the processes they influence and, in turn, what influences them. However, there is no definitive accounting of their community structures or dynamics.

By comparison, the quantitative relationships between the factors that influence the structure and chemistry of marsh soils, and the life histories and life requisites of some common plants and typically the economically more important crustaceans, finfish, birds (especially waterfowl) and mammals have been fairly well documented. Regarding targeted marsh plants and marsh-dependent animals species, hands-on insights of managers should not be dismissed. Over the years managers of individual marshes have acquired insights that might surpass the insights even skilled scientific observers might acquire from conducting multi-year studies. Unfortunately, insights acquired by managers from years of working with individual marshes are not always reflected well if at all in the documented record.

As can be seen from an inspection of the Literature Cited and Other References section of this PHMEIS, since about the mid-1980s, study efforts have become progressively more research intensive, tending to focus on examining the biologic dynamics of Louisiana's coastal marshes and specific groups of dependent plants and animals. Those initiatives have also tended to adopt a quantitative, experimental approach to documenting critical processes {e.g., microfaunal roles in marsh loss), examining components of marsh sediment budgets (Reed 1989 a, b; Nyman, Delaune and Patrick 1990; Reed and McKee 1991; Reed 1991)}. The change appears to have arisen about the same time as the popularity of MM began to rise, and apparently continues to interest researchers on broader scales (Callaway, Delaune and Patrick 1992).

Predicting future land loss locations and rates has been an area of recent interest. It has been a source of much interest to the CWPPRA initiative (Barras, Johnson and Johnson 1993). More insightful ways to predict and measure the response of targeted marshes to management has also been a topic of emerging interest (Boumans, Day and Kemp 1993b). Appendix D accomplishes that task for this PHMEIS.

The socioeconomic complexities of coastal Louisiana have long been appreciated but remain to be comprehensively characterized (see Appendix H). Davis (1983) and Davidson and Chabreck (1989) are examples of the more traditional perspective on the socioeconomics of coastal Louisiana's

marsh dependent resources. However, the economics of modern environmental management, including efforts focusing on restoration, is an emerging, dynamic discipline only now coming into its own in terms of economic theory and modeling (Turner, Pearce and Bateman 1993). The discipline has acknowledged the social implications of competing user groups. Some of those user groups have become very proactive (Gagliano and Roberts 1987, Chabreck 1994), but valuation is still the subject of theoretical discussion and measurement techniques are imprecise in some cases. Applied economics have focused on valuing some of the commercially and/or recreationally important species, and that trend continues but with a theoretical overtone (Shirley 1995).

Several major collections of papers are themselves milestones in the quest to understand the structure and function of Louisiana's coastal marshes and the effects of our activities, including management, in those marshes over the years. Newsom (1967), Chabreck (1973) and Day et al. (1978) archived the proceedings of symposia. General characterizations of Louisiana's hydroclimate, geological processes, recent sedimentary history, nearshore hydrologic processes, and synoptic treatments of the biology, ecology and socioeconomic resources are presented in Gosselink, Cordes and Parson (1979) for the Chenier Plain marshes and Gosselink (1984) for the Delta marshes. Duffy and Clark (1989) present a collection of research and overview papers. Several are particularly noteworthy because they demonstrate how interpretational study efforts (e.g., LeBlanc, 1989; Gagliano and Wicker 1989; Murphy 1989, Pezeshki et al., 1989), observational study efforts (e.g., Reed 1989), and manipulative or experimental study efforts (e.g., Mendelssohn and McKee (1987), individually and collectively, have advanced our insight into the structure and function of Louisiana's coastal marshes. Cahoon and Groat (1990) reported on the findings of a multiagency effort to discern the relationship between marsh management and selected attributes of Louisiana coastal marshes coast-wide by looking at the available historical records and performing short-term field investigations. Sweeney et al. (1990) and Cahoon (1990) illustrate what can be accomplished despite the complexity and unavoidable procedural constraints that are inherent to studying the effects of management. Those same papers also equally well illustrate the limitations, shortcomings and dangers associated with having to rely upon observational data and short-term field (one to two years) monitoring/data collection efforts to infer cause and effect relationships that serve as the basis for formulating accurate representations of longer-term system responses to management. The same caution would seemingly apply to short-term (less than three years) permit monitoring data sets.

4.3.4. Significant Physical, Geologic and Chemical Attributes

Significant attribute narratives were written so that the reader can see why the attribute is considered significant, what controls or influences it, and how it relates to other marsh attributes and management of Louisiana's coastal marshes. Citations were included to provide foundation. Citations from Louisiana were used when and where appropriate. However, for many biological attributes, particular emphasis is given to a publication edited by DeVoe and Baughman (1986) that comparatively profiled, through designed field studies, the biological community components of managed and unmanaged tidal marshes in coastal South Carolina. The physico-chemical setting in South Carolina is not identical. And, the management structures and operational schedules are not identical either. Nonetheless, because there is apparently no correspondingly comprehensive treatment of management of Louisiana's coastal marshes, this comparative approach is useful for a programmatic treatment.

Manipulation of several of these significant attributes are intentionally undertaken (or are caused to change as an unintended consequence) for two reasons. One is to achieve some immediate socioeconomic goal(s) (e.g., mineral rights protection, trespass control). The other is to initiate a sequence of interdependent physico-chemical changes/responses intended to modify conditions in managed areas sufficiently enough to ultimately, but indirectly, induce and foster particular biologic responses.

4.3.4.1. Hydrology

Water, sediments and salinity are inseparable, interdependent components of the hydrology in much of Louisiana's coastal marshes. For example, meteorological events that induce rising water levels generally correlate with increasing sediment concentrations in the water column (Childers and Day 1990a, Cahoon et al. 1995, Reed 1994, Reed 1989a) but any concurrent change in salinity quite often depends upon season (e.g., Chabreck 1960) and proximity to fresh water sources. The ability to design/use water control structures is critical, but especially so in marshes subjected to AMM, and some HR efforts, for the purpose of regenerating lost and/or revegetating eroded/exposable marsh soils (see Appendix B).

Exerting fairly precise (and in some cases repetitive) control over one or a combination of the components that comprise this significant attribute is a key to success. Water control structures, if they are properly sized and

operated, can be used to: 1) take advantage of favorable meteorological and hydrologic conditions while they persist; and, 2) regain hydrologic control as soon as possible after conditions pass that if allowed to persist or remain uncorrected would have overridden or proven counterproductive.

To what degree successfully manipulating the components of this significant attribute predictably have succeeded at forestalling or slowing, stopping or reversing marsh losses is inconclusive (Chabreck et al. 1978; Sweeney et al., 1990; Broussard, Undated). Thus, HM efforts that involve manipulating water levels to forestall, slow, stop or reverse marsh loss rates in managed areas should be regarded as a site-specific strategy with an unspecifiable performance potential. In contrast, when components of this significant attribute can be successfully manipulated, generally predictably successes arise relative to other biological management objectives (e.g., waterfowl habitat improvement).

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without manipulating this significant attribute. Water control structures typically used to manipulate this significant attribute may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users.

4.3.4.1.1. Water

Summary

In Louisiana's coastal marshes, water levels in and over unmanaged marsh soils are influenced differentially in space and time by winds, seasonal rainfall patterns, river stages and Gulf of Mexico tidal dynamics (Gosselink 1984; Gosselink, Cordes and Parsons 1979). The water that flows into, over and through Louisiana's coastal wetlands comes from intercepted rain, storm water runoff from uplands, rivers and from the Gulf. Seasonal and yearly rainfall, river and tidal dynamics have been characterized, and vary across the Louisiana coastal zone. They form an ever shifting mosaic of mixed sources. Project site characterizations, however, are generally assumed or inferred from observations, the vegetation and/or measurement of a limited number of variables.

How fast water moves over and through marsh soils influences other attributes commonly recognized as important to the health of marshes (e.g., sediments, soil and surface water

salinities, marsh soil transport, dissolved nutrient levels, waste removal). The collective relationship between slower moving water and those attribute has yet to be characterized comprehensively. Accordingly, managers have typically attempted to manipulate when, where and how quickly water enters and leaves and where water levels are relative to marsh soils in hydrologically managed marsh areas. Maintaining a balance that compliments the goal of a project, accommodates other significant attributes and is at the same time responsive to climatic and meteorological variations without compromising the integrity of the managed system can prove to be a real challenge.

Basis

The amount and duration of water level change over and within the upper several inches of the soil profile appears to be significant in determining plant distributions and species assemblages (Sasser 1977). Frequency of flooding is a measure of how often water occurs (e.g., an area may flood three times per month). Duration of flooding is a measure of how long an area remains flooded. It can be expressed per event (e.g., an area was flooded once for three days) or cumulated (e.g., an area was flooded twice, each time for three days, for a total of six days during the growing season). Depth of flooding is a measure of how deep the water is (e.g., the flood waters were three inches deep over the marsh surface).

Water moves at different speeds into (Boumans and Day 1990), within (Clark 1989a, Dean 1978, Dingler 1993), across and out (Boumans and Day 1990) of managed areas containing vegetated areas and open water. Organic marsh and pond soils are typically more subject to remobilization by moving water than are mineral soils (e.g., Gagliano and Wicker 1988). Thus, slowing surface water velocities (Dean 1978) emerged as a general rule to reduce the potential for marsh soil losses. The potential is greatest in a sparsely vegetated organic soil marsh.

4.3.4.1.2. Sediments

Summary

Affecting when, where and how much sediment enters, resides within and leaves hydrologically managed marsh areas has only recently been subjected to more rigorous scientific analyses. Early studies were inconclusive (e.g., Chabreck et al. 1978). However, based on more recent and rigorous studies the emerging evidence suggests that the accretionary processes operative in sediment dependent marsh types (intermediate, brackish and saline) are most probably

unavoidably impacted adversely when subjected to appreciable reductions in mineral sediment inputs over prolonged periods (Cahoon et al. 1995, Reed 1994, Reed 1989a). Thus, HM efforts that:

1) appreciably diminish mineral sediment inputs (to mineral dependent marsh types), and

2) are suspected of being (or can be demonstrated to be) incapable of-

   a- inducing prolonged, overwhelmingly positive organic matter production and retention/accumulation (relative to mineral sediment input reductions), and/or

   b- compensating for nutrient budget differences (relative to the role of mineral sediments as carriers of nutrients)

can be regarded as a less than optimal, unproven, and possibly suspect long-term approaches for forestalling, slowing, stopping or reversing marsh losses in site-specifically managed areas.

By increasing water clarity, growth conditions for aquatic vegetation attractive to waterfowl improve, especially if light penetrates to the pond bottom (Joanen and Glasgow 1965). However, the degree to which manipulations of this component of this significant attribute achieve any other stipulated biological management objectives (i.e., waterfowl habitat improvement) may be counterproductive to efforts to slow, stop or reverse marsh losses has yet to be documented.

Basis

Sediments are either mineral or organic. Organic sediments can be transported to an area by way of winds, water or man's action or produced within an area from plants and animals. Mineral sediments can be transported to an area in the same way but can't be produced within the area.

Sediment budgets on coastal, regional, basin and project site scales are characterized in qualitative terms and inferred from aerial photographs, observations and the literature. Increasing the production/retention of organic materials has been proposed as a way to reduce the sediment budget deficits and/or create a surplus of organic sediment in managed areas when mineral sediment inputs are believed to be inadequate to keep pace with subsidence.

Shallow open water areas apparently are temporary repositories for sediments before moving further toward the sea. Tides and storms apparently play a key role in the movement and retention patterns of marsh sediments (Reed 1989 a,b; Reed and Cahoon 1992; Reed and McKee 1991; Wang 1993). The dynamics of sediments presented to and that do move through or over water control structures or perimeter embankments, and to what degree any such sediments are delivered to the marsh surface and retained or exported, has been studied site-specifically in a few instances (Louisiana - Boumans and Day 1990; South Carolina - May and Zielinski 1986). Elsewhere, such studies serve as inferential models.

4.3.4.1.3. Salinity

Summary

Salinity tolerance is one of the classical attributes used to define Louisiana's four coastal marsh types (Penfound and Hathaway 1938, Chabreck 1972, Sasser 1977; see also Appendix A). Surface water salinity is very often subjected to manipulations, which impacts soil water salinity as well.

Salinity manipulations are attempted (Chabreck 1994) when trying to shift plant and/or animal species assemblages (Chabreck 1960) away from increasing saline conditions (reversal of marsh deterioration), and/or forestall, slow, stop or reverse marsh losses. Salinity manipulations range from attempted exclusions to suppressing average or maximum salinity levels.

Variation of summer rainfall patterns (DeLany 1988), violent storms (e.g., hurricanes) and naturally occurring seasonal salinity variations and water level differences have been identified as events that can individually or collectively preclude or override/overwhelm otherwise successful management efforts by elevating salinity to stressful or intolerant levels (Cowan et al. 1989). Additionally, delays or an inability to evacuate higher salinity waters (Meeder 1989) or offset periods of higher than intended salinity levels (e.g., too little or no fresher water to dilute salinities) are conditions that can thwart management efforts, or contribute to/cause adverse effects to managed marshes.

Success, at least in the short-term, depends upon managers exerting fairly precise and repetitive control over this significant attribute during favorable meteorologic and hydrologic conditions. The ability to configure water control structures to take advantage of favorable meteorological and to reduce/override counterproductive meteorological conditions, especially during the early

autumn through late winter of each year and late winter through early summer about once every three years (Chabreck 1960, Chabreck 1994) in marshes subject to AMM, is critical (Cowan et al. 1988). Some HM efforts have been partly effective in excluding (fresh marsh), or controlling (intermediate, brackish and/or saline marshes) salinity at least in the short-term (e.g., Craft and Kleinpeter 1988).

Managers and regulators should expect that a percentage of AMM and PMM plans won't perform up to expectations (AMM, PMM - Craft and Kleinpeter 1988, Latham et al. 1991, Meeder 1989, Mendelssohn and McKee 1987, Nyman et al. 1993, Sinicrope et al. 1990, Sweeney et al. 1990, Wiegert 1983). Without a record to review, and exclusive of HR projects designed to prolong/reestablish AMM over an area, the theoretically appealing concept of HR projects should have a full performance potential that could equal or exceed the performance records of the other forms of HM.

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without manipulating this significant attribute. Water control structures typically used to manipulate this significant attribute may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users.

Basis

In areas suffering marsh losses due to salinity-related problems, biologically meaningful suppression of salinity is generally accepted as necessary to slow, stop or reverse marsh losses. However, failure of or overtopping of a managed area's perimeter features during flooding situations could have catastrophic and even counterproductive effects on efforts to forestall, slow, stop or reverse marsh losses rates.

Some of the water that flows into, over and through much of Louisiana's coastal wetlands comes from the Gulf. Except for localized brine discharges, the Gulf is the principal source of salinity. There is no compelling evidence for any on-going general tend of increasing salinity (Fuller et al. 1990; Wiseman, Swenson and Power 1990) of Gulf waters that might itself approach a lethal threshold. However, salinity trends can vary locally on sub-basin scales (Wiseman and Inoue 1993). However, over the years, a general inland advance of Gulf-origin water has occurred that is suspected of being a function of sea level rise and impacts from man's surface activities on local hydrology. Regardless of the reason or scale, marsh losses have been predicted (DeLaune

et al. 1987) if local salinity levels increase enough, even in the short-term (as salinity spikes).

Salinity records from 50 stations date from 1946 (Gagliano et al. 1973). Variability of the data was such that short-term differences were believed to be poor indicators of long-term trends (Gagliano et al. 1973).

Salinity regimes exhibit patterns related to seasonal and yearly rainfall as well as river levels (Gagliano et al. 1973) and storm events that have coastal, regional, basin and individual project site signatures (Gagliano et al. 1973). The result is a shifting, temporal and spatial mosaic of salinity concentrations even at the local scale.

Historically, successfully controlling project site salinity has very often been considered a requisite for successful management. That perception was apparently often dictated by the purpose(s)/goal(s) of projects. A need to control salinity will continue to be a tool available to managers in their efforts to manage marshes, but is not a "goal" or "purpose" of any project.

Attempts to control salinity within managed areas is a way to affect a change in some other attribute of the targeted marsh. The success of efforts to control salinity have typically been judged according to the purpose of the project (Craft and Kleinpeter 1989). Results have been mixed. Average salinities have tended to decrease or remain about the same, but local rainfall and retention of intruding, overtopping, salt-carrying storm waters (DeLany 1988, Meeder 1989) can prolong the duration of elevated salinity conditions. Monitoring results also suggest that salinity gradients can also arise within managed areas (Roberts and Sauvage 1988, Anonymous 1989?).

The monitoring results reported by Clark (1989a) and Rogers, Herke and Knudsen (1987, 1992) and Turner, Day and Gosselink (1989) are evidence of how variable salinity responses can be to management. Typically designed and operated management programs, but for the unpredictability of local climatic, tidal and storm influences, probably would tend to lower average salinities. However, the type of structure used can also have an apparently great effect on the salinity regime. For example, Rogers, Herke and Knudsen (1987) reported salinities within areas managed by two different weirs were on the average lower than behind a slotted weir. However, salinity behind a fixed-crest weir exhibited a cyclical pattern of alternating periods of several days with lower than average salinity followed by periods of several days with higher than average salinity. In contrast, salinity behind the verticle-slotted weir on

average was higher than behind the fixed-crest weir but varied a great deal lees about the average. The average salinity behind the fixed-crest weir was lower but the amplitude of the change and variation over time was much less behind the verticle-slotted weir. The effects on the marsh vegetation would depend on their tolerances to such management-induced variations.

4.3.4.1.3.1. Concentration/Duration

Long-term Gulf salinity levels have not increased, but they do exhibit year-to-year and seasonal variations. Rainfall, upland runoff, and the salinity concentration of water available to dilute Gulf waters interact to influence surface water salinity concentration gradients at local, basin-wide, regional and coastwide scales. However, once within a marsh, surface water salinities can be additionally modified through the expression of tides, gravity (or pump controlled) drainage, wind speed and direction, and evapotraspiration.

Salinity, especially as it affects soil growth conditions, is a significant modifier of plant growth conditions (DeLaune, Pezeshki and Patrick 1987; Craft and Kleinpeter 1988; Latham, Pearlstein and Kitchens 1991; Linthurst and Seneca 1981; Meeder 1989; Pezeshki, DeLaune and Patrick, Jr. 1987b; Webb 1983) with potential deadly consequences (Pezeshki, DeLaune and Patrick 1987a; Webb 1983). Daily, monthly and seasonal climatic variations affect both local water level dynamics and water chemistry conditions (Barlow 1956).

4.3.4.1.3.2. Depth/Penetration

Soil water salinity concentrations, especially throughout the root zone, also influence marsh plants and the structure and function of marshes. Soil water salinities can be lower but generally are higher than surface water salinities at any given time. However, the probability that soil water salinities will rise increases if higher surface water salinities remain in an area. Surface and internal drainage characteristics of the soil influence how quickly and deeply higher salinity waters may penetrate as well as how quickly any changes may be reversed.

Surface water salinities tend to exhibit higher levels during the summer months. During the summer, tidal heights and monthly average rainfall volumes are a little higher but the range in tidal changes is smaller. The result is that somewhat saltier water conditions occur nearer or at the marsh surface. During the summer, rainfall is also typically very spotty (associated with localized

thunderstorms) and daily temperatures rise persistently to nearly yearly highs. Water evaporates more rapidly than at other times of the year and the marsh plants' requirement for water with tolerable levels of salinity is near the yearly high. The salinity concentration of slow moving or stagnant surface water can rise to stressful or even toxic levels.

Regardless of marsh type, salinity, in combination with low or no oxygen soil conditions in the root zone, can, as the result of chemical reactions, affect/immobilize plant nutrients (Pezeshki and DeLaune 1990; Day et al. 1989), affect plant physiology (Pezeshki, DeLaune 1987; Pezeshki et al. 1989) and growth patterns (Pezeshki and DeLaune 1990; Pezeshki, Matthews and DeLaune 1990), and, if conditions persist, can accentuate the build-up of compounds toxic to plant growth (Pezeshki, DeLaune and Pan 1991; Mendelssohn, McKee and Patrick 1981). Prolongation of such conditions can lead to the death of many if not all of the affected marsh plants (Koch and Mendelssohn 1989).

The role of salinity as a locally important modifier is evidenced in two ways. Salinity can affect which marsh plants occur where, based upon individual plant species' salinity tolerances (Chabreck 1972, Sasser 1977, Smart and Barko 1980). Salinity can also affect the presence or absence of marsh plants via salinity's ability to influence marsh soil chemistry (Linthurst and Seneca 1981; Meeder 1989; Pezeshki, Delaune and Patrick 1987; Craft and Kleinpeter 1988; Latham, Pearlstein and Kitchens 1991).

Marsh losses have been shown to be the result of more than just salt water intrusion, erosion due to tidal action or waterlogging. Within any single tidal marsh type, salinity levels could often be a secondary problem. But, it would be a mistake to ignore salinity, especially if the average and the local long-term trend is increasing relative to the tolerances of the native plant species or the plant species that would result from management, or the managed areas encompasses more than one marsh type. In such cases, management that strives to maintain ambient salinity differences across the included marsh types but within tolerances would seem to have a greater potential to perpetuate the include marsh types.

4.3.4.2. Subsurface Geology/Sea Level Rise

Summary

HM efforts cannot slow, stop or reverse the subsurface geologic processes that dictate the rate at which the land (marsh) surface naturally retreats from a naturally rising

sea level. However, HM efforts can attempt to forestall, or slow, stop or reverse actual marsh losses by elevating the marsh surface at a rate that equals or exceeds the speed at which the marsh and water surfaces diverge.

HM efforts that:

1) appreciably diminish mineral sediment inputs (to mineral dependent marsh types), and

2) are suspected of being (or can be demonstrated to be) incapable of-

   a- inducing prolonged, overwhelmingly positive organic matter production and retention/accumulation (relative to mineral sediment input reductions), and/or

   b- compensating for nutrient budget differences (relative to the role of mineral sediments as carriers of nutrients)

can be regarded as a less than optimal, unproven, and possibly suspect long-term strategy for forestalling, slowing, stopping, or reversing marsh losses (actual marsh gain) in managed areas. However, such efforts may enhance marsh plant standing crop biomass and/or diversity, as well as temporarily expand the amount of surface covered by emergent marsh plants, thereby achieving an apparent marsh gain.

Efforts to achieve some socioeconomic management objectives (e.g., protection of property or mineral rights) are often initiated in response to this significant attribute but can be achieved through other means. Water control structures typically used to manipulate other significant attributes may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users.

Basis

The Pleistocene formation is a stable geologic formation. It is the platform upon which the materials have been deposited from the Mississippi and Atchafalaya Rivers and Gulf processes over the last 70 centuries. How deep that platform is from the soil surface affects how much the overlying soil can naturally settle and compact. Organic soils naturally tend to compact more and faster than mineral soils. Therefore, deep organic soils have a greater capacity to show vertical elevation differences.

Stable though it is, the Pleistocene formation is not flat. It slopes toward the Gulf, in some places more than others. Thus, regardless of the soil type, there is a tendency, in response to gravity, for soils on the Pleistocene platform to slide down the slope of the formation to the Gulf.

Different soil compaction potentials and rates of sliding create differences in the rate at which the land (marsh) surface naturally subsides relative to sea level throughout Louisiana's coastal zone. The result can be visualized as an undulating surface, some spots higher and some spots lower than others. The elevations continuously change, both in terms of absolute elevation and in terms of sea level changes. The higher areas tend to remain higher longer and the lower areas tend to become lower more quickly.

At the coastal scale, the higher spots would tend to occur where the Pleistocene is within 20 to 30 feet of the surface and where the remnants of former, natural river levees and nearby overflow plains exist. At the regional scale, the same patterns can be seen especially where smaller distributaries occurred. At the basin scale, the undulating pattern becomes even more finer grained. At the project site scale, elevation differences can be observed, or inferred from the vegetation, are seldom measured but referenced relative to planned water level manipulations.

4.3.4.3. Surface Geomorphology

Summary

The surface geomorphology of Louisiana's coastal marshes has been unquestionably modified, intentionally as well as unintentionally, by socioeconomic pursuits as well as management efforts. As a result, the hydrology of much of Louisiana's coastal marshes was modified. The spectrum of consequent impacts to many physico-chemical, biological and socioeconomic attributes were not always apparent, immediate or positive or of concern at the time projects were implemented.

Coastwide that overall trend may slow but not reverse itself (see CWPPRA project profiles). In some basins (e.g., Basins 5 and 9) the trend may actually accelerate, with the concomitant implications to hydrology, marsh vegetation dynamics and socioeconomics. However, generally greater efforts are expended to characterize and then design projects to minimize unavoidable adverse impacts.

Successfully manipulating this significant attribute has never been a stipulated reason for undertaking a HM project. However, the installation/rehabilitation of some surface

landscape features for HM purposes has the unavoidable potential to also address several socioeconomic interests.

Basis

Naturally higher elevations (e.g., bayou levees and ridges) influence water movement patterns. Man has created surface landscape features (e.g., disposal and flood control levees, canal systems, water control structures) that have induced changes in the historic surface water movement patterns throughout much of coastal Louisiana (Turner 1987, Swenson and Turner 1987, Turner et al. 1989). Those features arose from efforts to extract petroleum resources, enhance the efficiency of and stimulate the growth of waterborne commerce, delineate property boundaries, conduct agricultural operations, protect against flooding, and improve habitat and recreational opportunities.

4.3.4.4. Marsh Ponds/Open Water Areas

The concept of marsh includes shallow open water areas. Pond areas are natural, historic features of many marshes. An expansion of open water areas resulting from marsh losses has occurred since the mid-1930's and is expected to continue (see Appendix D).

Successfully manipulating this significant attribute has never been a stipulated reason for undertaking a HM project, but its modification is often perceived to be one of the necessary intermediate steps to achieving overall projects purposes. HM projects have been/can be designed to expand, maintain or reduce this significant attribute.

Manipulating the size (surface area) of ponds/open water areas has been and is likely to continue to be something to facilitate achieving other goals/objectives (e.g., wildlife, apparent/actual marsh loss). Water level reductions can be attempted in areas that can be made hydrologically independent from the surrounding marsh (i.e., semi-impounded management areas subjected to AMM or HR projects intent upon prolonging an ongoing or reestablishing a former AMM presence).

Apparent reductions of pond/open water surface areas are achieved when water levels are reduced to foster apparent or actual marsh gains or improve aquatic plant growth conditions. Apparent reductions may be different from year to year. Actual reductions occur in direct proportion to actual marsh gains.

In some basins (e.g., Basins 5 and 9) HM efforts targeting this significant attribute may accelerate (see CWPPRA), with

the concomitant implications to hydrology, marsh vegetation dynamics and socioeconomics. However, generally greater efforts are expended to characterize and then design projects to minimize unavoidable adverse impacts.

HM efforts that attempt to manipulate pond/open water areas unavoidably and appreciably diminish mineral sediment inputs to mineral sediment dependent marsh types (Boumans, Roel and Day 1990, Reed 1989a, Reed and Cahoon 1992, 1993), at least in the short-term. Projects suspected of being unable to or that fail to induce a documentable, prolonged, compensatory positive effect on soil development due to organic matter production/accumulation (Cahoon and Groat 1990, Nyman 1993c), or that don't succeed at reducing water levels to target elevations as frequently as called for in management plans, appear to entail certain and unavoidable adverse consequences without appreciably offsetting benefits.

HM efforts that prolong the depth and/or duration of flooding should be regarded as having a real potential to indirectly (Sasser 1977, Burdick et al. 1989, Kock and Mendelssohn 1989, Mendelssohn et al. 1988) or directly (e.g., Nyman et al. 1994) increase the size and/or interspersion of ponds/open water areas. These, too, adversely impact sediment dynamics.

Thus, HM efforts that include a provision to manipulate water levels in ponds/open water areas to forestall, slow, stop or reverse marsh loss rates in managed areas should be regarded as a site-specific strategy with an unspecifiable performance potential. In contrast, when this significant attribute can be successfully manipulated, generally predictably successes arise relative to other typically stipulated biological management objectives (e.g., waterfowl habitat improvement).

4.3.4.4.1. Size

Pond/open water size reduction has been, is and is expected to be a desirable component of some HM efforts, especially if apparent or actual marsh gains occur. Marshes that include shallow open water areas exhibit a greater number of dependent species. That is especially true relative to fishery resources.

Water level control, more particularly periodic water level reduction, temporarily draws the water edge away from the vegetated pond margin. The potential for wave-induced erosion of the pond margin is theoretically reduced for as long as the water level remains lowered. What was the vegetated margin of a pond (made smaller by water level reduction) is consequently less subject to the erosive

effects of wind-induced waves. If emergent vegetation can be induced to grow on the exposed substrates, the erosive forces can be further diminished (Dean 1978). Accordingly, wave-induced shoreline marsh loss and events of elevated turbidity levels may occur less often and/or persist for briefer periods in smaller ponds.

The ideal ratio of marsh area to pond area is unknown. However, a commonly referred to range with positive implications to waterfowl management interests is about 70 % (marsh) - 30 % (open water) (NRCS, comment letter dated November 15, 1995).

Clearly, periodic water level reduction has indirect implications to a wide range of marsh system significant attributes (e.g., emergent vegetation - favorably impacted, mineral sediment and fisheries - adversely impacted).

4.3.4.4.2. Depth

Marsh ponds/open water areas range in depth from just a few inches to several feet deep. Some impacts of lowering water levels were characterized immediately above. When water levels are manipulated, pond depth is also unavoidably and correspondingly impacted.

Manipulating water/pond depths unavoidably affects other significant attributes. Examples follow.

Reduced pond depths contribute to clearer water. Wave action in shallower ponds is reduced, disturbing the bottom less. Secondly, exposing some or all of a pond bottom fosters consolidation/demobilization of pond bottom materials for one to two growing seasons. However, it also reduces/eliminates mineral sediment inputs to marshes subjected to such seasonal water level manipulations. Nonetheless, the resulting clearer water favors the growth of submerged aquatic vegetation (Joanen and Glasgow 1965).

Pond depths of 18 inches or less are especially conducive to the growth of submerged aquatic vegetation (Joanen and Glasgow 1965). Upon reflooding, the aquatic and or emergent vegetation attenuates wave action, contributes to primary production, increases aquatic habitat diversity, etc., and increases the attractiveness of the managed area to waterfowl.

In addition to the unintended but unavoidable effects on several significant biological attributes, especially fisheries, lowering water levels temporarily reduces/eliminates access to the some or maybe most if not all of the managed area by watercraft. Water control

structures can also be used to maintain water depths at levels that facilitate movements of watercraft (Chabreck and Nyman 1989) at times of the year when the natural rhythm and dynamics of the hydrology could preclude watercraft access for brief periods.

4.3.4.4.3. Interspersion/Persistence

Marshes with some, preferably small ponds/open water areas, are more desirable than expanses of solid (also called unbroken) marsh from the standpoint of habitat and species diversity and recreational/commercial fish and wildlife potentials. Marshes interspersed with ponds/open water areas have more associated animals than marshes with no open water/pond features.

Attempts to adjust the spatial distribution of pond/open water components within marsh areas has direct and immediate implications to fisheries, other aquatic organisms, aquatic productivity, as well as waterfowl/wildlife but generally indirect implications to marsh loss reduction interests.

The standing crop of phyto-plankton, aquatic vegetation, phytoplankton and fisheries is generally higher in marshes with ponds and/or areas of shallow open water.

Ponds can be made to occur in an otherwise solid stand of emergent vegetation through flooding (intentionally induced stress from waterlogging), dredging, or the judicious use of explosives. Marsh plants intolerant of the induced flooding regime die, creating open water areas. Interspersion is increased but not necessarily in the desired pattern. In contrast very specific interspersion patterns can be manufactured and maintained by dredging and/or using explosives.

Using planned water level manipulations to induce the growth of marsh plants on exposable substrates could effect interspersion. Theoretically, interspersion could be reduced to zero. Practically, retaining ponds/open water areas has overriding recreation and commercial implications.

There is state-level statutory relief from open water resulting from marsh loss. Land owners that succeed at reestablishing their properties to a condition in the 1920's may also protect/reclaim their mineral rights.

4.3.4.5. Marsh and Pond Soils

Retention of marsh and pond soils at elevations (relative to natural or managed water levels) that are conducive to the reestablishment or more luxuriant growth of marsh and/or

pond plant species are commonly recognized as important indirect elements in efforts to slow, stop or reverse marsh loss.

Regeneration of eroded soils to uneroded elevations (by retaining organic and mineral sediments), with subsequent revegetation (actual marsh gain), has emerged as a goal of many HM efforts.

See also the discussion at the Hydrology significant attribute headings.

4.3.4.5.1. Marsh Soils

Regardless of whether they are organic or mineral, eroded or not, marsh soils are important because they are the medium within which organisms exist, chemical reactions occur and plants anchor themselves and derive/extract life requisite resources.

Historically, management has focused more on what can be made to grow on managed pond and marsh soils in support of other interests. More recently, the perspective has broadened to include retaining and the possible recreation of marsh soils. The interest is wide-spread but more acute in the Delta. Most Deltaic soils are typically organic and therefore transportable (Touchet 1994).

Theoretical (e.g., Dean 1978; Hanson, Kraus and Nakashima 1989; McBride 1989) and applied management (e.g., Seidensticker and Nailon 1987) are resulting in reduced shoreline erosion rates from vegetative plantings and wave barriers. Existing methods have theoretical appeal at arresting marsh losses through water level stabilization but Nyman (1993e) has proposed a loss mechanism suggesting that water levels stabilized near or below the root zone (5 to 6 inches below marsh level) could undermine the emergent vegetation along the marsh water interface. However, project areas are typically several thousand acres in size (Appendixes C and Q). As such, they can be expected to encompass more than one soil type, each with its own unique characteristics (Appendix B), and often several different marsh types (Appendixes C and Q).

4.3.4.5.1.1. Surface Elevation/Water Depth

Where water is relative to the marsh soil surface is ever changing. Even if the surface elevation of a Louisiana delta or chenier marsh soil never changed, the elevation of the marsh soil surface relative to the ever changing water surface is never stable. The relationship between soil elevation and water level is extremely important to marsh

plants (McKee and Patrick 1988; Mendelssohn and McKee 1987,1988; Burdick 1989). The relationship is so basic that the distribution of Louisiana's marsh plants has been characterized, and can be fairly well predicted, knowing the range of water levels and the soil surface elevation (Sasser 1977) and something about a single water quality attribute, salinity (Latham, Pearlstein and Kitchens 1991). Marsh soil chemistry, marsh plant communities and marsh dependent animal species reflect and respond to the frequency and amplitude of oscillations.

In some freshwater marshes, water is nearly always at or above the marsh soil surface. In tidal marshes, whether or not they are influenced by salt water, water levels naturally oscillate. Water levels can oscillate above the soil surface (more often in fresh marshes), or from above to below the soil surface. Naturally occurring multi-day events, when marsh substrates are temporarily exposed to the atmosphere, are more prevalent in winter or early spring with the passage of weather fronts.

The depth to which water levels naturally or are induced to descend into the marsh soil profile pretty much determines the width of the marsh soil profile within which marsh plants can send their roots to anchor themselves and still acquire nutrients in an oxygenated environment. Deeper than that, or to survive in a constantly flooded soil condition, marsh plant root systems must be able to acquire nutrients from the soil and water through means that can operate with little or no oxygen (Kozlowski 1984). Only a few of Louisiana's coastal marsh plants can sustain themselves for very long in soils that remain flooded for more than a week or two, especially when there is little or no oxygen (Gleason and Zieman 1981; Mendelssohn, McKee and Patrick 1981).

4.3.4.5.1.2. Persistence

Naturally occurring events that cause water to recede to levels that expose the upper-most soil surface to the atmosphere enough to dry the extreme upper layers help retain organic material transported to and/or produced locally, as well as mineral sediment transported to and/or reworked from elsewhere within the marsh. Such naturally occurring events are part of the natural accretion process that may offset the erosional processes that affect marsh soils (Cahoon 1990).

Most individuals involved with the management of marshes are aware that losing marsh soils without a corresponding decrease in water level diminishes the suitability of the soil to function as a substrate for emergent plant growth

due to the consequent effects of "waterlogging" (on the physio-chemical attributes of the marsh soil) and salinity intrusion. Management related water level reductions are also purported to maintain soil surface elevations by avoiding the effects of waterlogging and accentuating the capture of the greater amounts of organic matter produced by invigorating plant growth to maintain.

Several authors have suggested that root growth dynamics explain some of the difference between soil surface elevations and sea level. As roots grow the area they occupy expands. Part of the root mass expansion involves roots that grow into newly accreated sediments, thereby immobilizing them and elevating the surface of the marsh, presumably in some proportion relative to sea level. This explanation is seemingly contingent upon plants undergoing root zone expansion at a time that coincidentally corresponds to sediment depositions (e.g., spring flooding) on some predictable schedule, or that the plants are capable of responding fairly rapidly to physico-chemical changes in the soil profile induced when some unknown amount of mineral and/or organic material is deposited on the marsh surface and retained in place long enough for the roots mass to respond.

Management that diminishes sediment delivery to the marsh surface (Reed 1989a, Cahoon 1991) at the time when root zone expansion is on-going could be counterproductive to an unknown degree to efforts to slow, stop or reverse marsh loss (Cahoon 1991). However, intentional water level reductions are commonly recognized as a way to immobilize sediments, often as a desired consequence relative to other significant attributes (e.g., submerged aquatic vegetation) and management purposes.

The passage of weather fronts during the late fall, winter and spring have been shown to be periods of great sediment mobility (Baumann et al. 1984) and delivery to the marsh surface (Reed 1989a). Emergent plant growth rates during winter and very early spring are minimal or nonexistent. Thus, if late-fall to early spring sediment movements are involved with marsh surface elevations dynamics, then retention or loss of sediments could be mediated by differentially operative mechanisms depending upon season. Hurricanes and storms (Jackson, Foote and Ballisteri 1995; Reed 1989a; Rejmanek et al. 1988; Meeder 1987; Baumann et al. 1984) are also capable of delivering large volumes of sediments to the marsh surface. That material may or may not be immediately retained to any appreciable degree (Boumans and Day 1990). The repository for at least some of those sediments appears to be marsh ponds. Theoretically, some proportion of those sediments may be reintroduced to

the marsh surface during tidal movements driven by more moderate weather events. Sediment retention could be facilitated when the marsh surface is naturally exposed to the drying effects of the atmosphere for up to several days after frontal passage, creating a thin veneer of sediments into which roots can expand. Management that suppresses tidal movements capable of remobilizing sediments into marshes dependent upon them could adversely affect marsh surface/water level dynamics (Childers and Day 1990a, Cahoon 1991). However, once an area has been brought under management breaching of perimeter structures could also adversely affect the management program by allowing for the export of any retained material.

If there are indeed seasonal mechanisms at work affecting the marsh surface water level relationship, then marsh plants that can produce roots that originate just above the soil line and extend into the soil during the growing season would in effect create a "root net" that could capture sediments delivered to the marsh surface during the normally occurring higher late-spring through early fall-tides. Nyman at the EPA's workshop on structural MM (August 1994) commented on such a possibility.

Enhancing root zone expansion through water level control/planned reductions has the potential to offset, to some unknown degree, marsh surface elevation reduction relative to sea level and/or subsidence over what could be expected to occur without management. So, too, might Nyman's observations about the production of aboveground roots. But, both are also tied to when and in what amounts sediments are delivered to the marsh surface. Management actions that suppress the delivery of sediments to targeted marshes (including flow-through designs), especially the more sediment dependent marsh types (ie, brackish and saline) and/or suppress water level fluctuations within targeted marshes to the point that sediments are delivered to the marsh surface in greatly reduced amounts, or their delivery mechanism is temporarily eliminated on some regular basis, have been characterized as potentially counter productive to management efforts undertaken to slow, stop or reverse marsh losses (Cahoon 1994, Cahoon and Day 1991, Childers and Day 1990a, Dingler 1993).

In contrast, Nyman, at EPA's workshop on structural MM (August 1994), commented that fresh marshes depend more on belowground growth to maintain elevations than on mineral sediment accretions.

4.3.4.5.1.3. Composition

Native marsh soils are preferred. However, a marsh soil

that supports emergent vegetation, even if the ability of the soil to sustain emergent plant growth is artificially sustained, is better than no soil.

4.3.4.5.2. Soils of Marsh Ponds

Soils of marsh ponds are usually targeted for management to induce changes indirectly beneficial to targeted wildlife species. Typically, the intent is to stabilize substrates to encourage the growth of submerged aquatics. Recent work by several investigators (e.g., Sweeney et al. 1990, Reed 1992, 1989a, Reed and Cahoon 1992, Reed and McKee 1991, Boumans and Day 1990, Day et al. 1986) suggests water level reductions in general, and especially those designed to consolidate pond substrates, when performed on a regular, short frequency, repetitive basis, could have adverse implications to the mineral sediment dynamics of some marshes, as well as other significant attributes (e.g., Reed 1994) .

4.3.4.5.2.1. Surface elevation

Manipulating water depths over and within these soil profiles is undertaken to create soil growth conditions conducive to inducing/invigorating the growth of submerged aquatic vegetation (Joanen and Glasgow 1965) and possibly inducing the growth of emergent marsh grasses, especially along ponds edges, thus contributing to slowing, stopping or reversing the erosion of marshes.

4.3.4.5.2.2. Water Depth

Seasonally adjusting, including in some cases planned, periodic reductions of marsh pond soil profile water levels, or simply diminishing the variation in depth of water in ponds, is undertaken for two principal reasons. They are to slow, halt or reverse the loss of pond soils through wave and tidal action, and improvement of growing conditions for rooted submerged aquatic vegetation.

Some significant attributes are benefitted, others may show no relationship to this management action while other significant attributes may be adversely impacted.

4.3.4.5.2.3. Persistence

Seasonally adjusting, including in some cases planned, periodic reductions of marsh pond soil profile water levels, or simply diminishing the variation in depth of water in ponds, contributes to slowing or halting losses of pond soils, and perpetuates the retention by ponds of mobilized marsh soils, thereby, aiding in slowing marsh erosion.

4.3.4.5.2.4. Composition/Consistency

Soils that consist of unconsolidated organic matter are subject to erosion and are not conducive to the growth of submerged aquatic vegetation.

4.3.4.6. Temperature, Oxygen and Nutrients

Summary

These significant attributes have never been given principal attention. However, they are almost always affected unintentionally in every HM effort. The linkage between sediments and nutrients dynamics of marshes is receiving more scientific scrutiny (Childers and Day 1990b, Delaune et al. 1982).

Basis

Surface water temperatures exhibit seasonal, daily and localized differences. Water temperatures are lowest during the winter and early spring and highest during the summer and early fall. Shallow water areas can exhibit greater daily variations than do deeper water areas. Additionally, localized rainfall events (e.g., thunderstorms) can lower shallow surface water temperatures rapidly.

Oxygen is important because of its essential biochemical role in higher marsh life forms such as zoo and phytoplankton, benthic worms, fish, birds and mammals. For those organisms dissolved oxygen levels dictate the potential for the water to sustain life functions. Oxygen-using marsh species exhibit different thresholds of minimum necessary dissolved oxygen levels. For example, menhaden require higher minimum levels of dissolved oxygen than do crabs. The common marsh grass Spartina also exhibits physiological responses to different soil oxygen conditions (Gleason and Zieman 1981, Mendelssohn et al. 1981).

Dissolved oxygen levels exhibit patterns in space and time. As water temperatures rise during the warmer months, less oxygen occurs per unit volume of water. Dissolved oxygen levels typically differ between nighttime and daylight hours. Water surfaces are generally more well oxygenated but the differences in wind-mixed marsh ponds may be negligible.

Slower moving waters may exhibit lower dissolved oxygen levels than waters that are more strongly influenced by tides and winds. Rainfall from thunderstorms can locally change dissolved oxygen levels as can pumped inputs and river diversions.

However, oxygen is not essential to all marsh forms and is toxic to some marsh life (e.g., anaerobic bacteria). Bacteria, and some algae, are examples. Instead of oxygen some microorganisms can use nitrogen, while still others rely upon sulphur to perform the biochemical duties that oxygen performs for other species.

Nitrogen and sulphur occur in various organic and inorganic forms in the different Louisiana coastal marshes. They also occur at different depths within the marsh soil profiles and exhibit seasonal differences as well. Correspondingly, microorganisms exhibit a diversity that reflects those differences as well as many others. The interrelationships are the routes by which nutrients and energy flow into, through and out of Louisiana's coastal marshes.

Nitrogen, iron and phosphorus are very common chemical constituents of the marsh environment and along with sulphur, regulate plant growth. Those same chemical constituents are themselves influenced by marsh soil bacteria. In turn marsh soil bacteria are influenced by temperature, oxygen levels and pH.

Nitrogen can be the most limiting plant nutrient in flooded marsh soils. Nitrogen is an essential constituent of amino acids, building block of protein. Organic matter (both locally produced as well as imported) and the atmosphere are principal sources of nitrogen. Atmospheric nitrogen dissolved in water is made available (as ammonium) to marsh plants and phytoplankton through the action of a group of bacteria and algae in the portion of the soil profile that lacks oxygen. Organic nitrogen (e.g., plant biomass, detritus) is converted to a form (ammonium ion) that can be used by plants directly and/or can be converted by other microorganisms to another chemical form that is also useable by plants provided there is an oxygenated soil surface layer. If there is no surface oxygen layer in the marsh soil profile, the ammonium concentration can build up to levels that can stress or kill marsh plants. Nitrogen is lost through the export of organic matter, as an ionic form that is very mobile in solution, or due to the conversion of organic nitrogen to nitrogen gas affected by another set of microorganisms that thrive in the absence of oxygen.

Iron, as a plant nutrient, is not limiting to marsh plant growth. However, its chemical behavior in marsh soils can result in the creation of an iron compound that can be stressful or toxic when it rapidly joins with phosphorous. Iron exists in two forms in marsh soil water. One form is soluble and, therefore, available to plants as a nutrient. The other form is not soluble. The soluble form is electrochemically converted to the insoluble form in the

presence of oxygen and when the pH is neutral or basic. However, that conversion occurs many times more quickly when a certain kind of bacteria is present to act as a biologic catalyst. This is a reversible reaction.

Phosphorous is not a limiting plant nutrient in estuarine systems but, like iron, it's chemical behavior in marsh soils can be influential. Phosphorous inputs include point-source outfalls (e.g., sewerage treatment plants), transported mineral sediments (with their electrostatically attached phosphorous) and dissolved inorganic and organic forms. Some marsh bacteria convert dissolved organic phosphorous to dissolved inorganic phosphorous and this conversion occurs more vigorously in winter when oxygen levels are higher and temperatures are cooler and algal compositions reflect those seasonal differences. Other kinds of marsh bacteria transform available dissolved inorganic phosphorous into organic phosphorous. As soils become lacking in oxygen, inorganic phosphorous attached to clay particles is released and iron-phosphorous complexes break down releasing soluble phosphorous forms. Shifts in pH through the production of organic acids (e.g., sulfuric acid) can also release complexed phosphorous but in acid conditions phosphorous is quick to bind to clay particles. These reactions occur both in the water column as well as marsh soil water.

Sulphur, like nitrogen, can occur in several forms and bacteria and other microorganisms are influential. Sulphur concentrations, as sulphate, in sea water is very high. The conversion of sulphate to hydrogen sulfides is not pH limited and occurs as the result of bacterial action in the absence of oxygen. Sulfides are directly toxic to microorganisms and have been suggested as the reason inland marsh plants (where drainage is typically poorer) exhibit lower vigor. Sulfides can affect marsh plant growth because sulphur becomes less available for plant growth and as do zinc and copper, other micronutrients, when they complex with sulfides. Additionally, sulfides, when exposed to oxygen (such as during a managed water level reduction), can be chemically converted to sulfuric acid which is also stressful/toxic to marsh plants.

Management of water levels, sediments, flow patterns and water chemistry can directly affect the chemistry of marsh soils, the structure and function of the phytoplankton and microbial components of managed marshes. Because water level regimes are often very similar between managed areas, management's effects on nutrient dynamics should be a function of the total area involved in management, sources of microbial communities and how the chemistry of the involved soils and the phytoplankton and microbial community

components respond to management.

4.3.4.7. Summary- Potential for HM Efforts to Effect Significant Physico-chemical Attributes

HM actions are undertaken with the intention of setting in motion a series of reactions. If the intended manipulations (and reactions) can be scaled to reduce/mute/override counterproductive meteorological/hydrologic conditions (and/or take better advantage of favorable conditions) relative to the sensitivity/reactivity of the targeted significant attributes, then managers can expect to induce proportionate and sequential changes. Over time and space those changes may prove to be conducive to and, thereby, foster the desired response by marsh plants and/or dependent animal species.

Deliberately manipulating aspects of the hydrology of targeted marshes is the recognized key. Nonetheless, predictively quantifying the intended effects in managed areas is not a well developed aspect of HM.

The effect of natural meteorological variation on local hydrology would seem to be a manager's ally almost as often as it is an adversary.

The potential to encompass several soil and marsh types is nearly always noted. Consideration for marsh soils seems to have focused on what plant species the included soils can support in a managed condition and what structures can be effectively supported by the soils. Far less consideration has apparently been given to the potential physico-chemical and biological consequences of subjecting multiple soil and marsh types to uniform hydrologic conditions (see Appendix A).

Predictively quantifying the unintended effects of management efforts in targeted Louisiana marshes and surrounding areas has received less attention and is, therefore, an even more illusive task.

Historic HM efforts (i.e., AMM and PMM) appear to cause similar types of effects on many significant physico-chemical attributes. However, AMM has the potential to have more intensive quantitative effects on targeted as well as non-targeted attributes. The case for HR has yet to be made. However, the largely theoretical relationship should be AMM$\geq$HR$\geq$PMM.

Whether management induced differences affecting significant physico-chemical attributes are beneficial or adverse is in the eye of the beholder and is judged by how significant

biological and socioeconomic attributes respond.

4.3.5. Significant Biological Attributes

4.3.5.1. Primary Production

Summary

From the managers perspective, the effects of HM efforts on bacteria and phytoplankton have not, are not and are not foreseen to be of much immediate consequence. In contrast, HM efforts that attempt to increase and retain greater volumes of plant material production from the invigorated growth of aquatic and emergent marsh plants, sometimes producible within more intensively managed areas, have recently and apparently will continue to be of interest to managers concerned with forestalling, slowing, stopping or reversing marsh loss.

Several papers describe observations or relationships. Others report on how statistically certain a studied relationship may be, infer biological relationships and then offer conclusions, explanations, or applications of the relationship. Others demonstrate a cause and effect relationship. Individually, those focused on some very interesting but quite limited aspects of primary production in marshes.

In Louisiana Allen (1975) studied aquatic primary productivity in various marsh environments, including managed ponds. He reported that, ".... as the physical and chemical factors change in the ecosystem, a corresponding biological switch occurs, with no apparent influence in productivity." Kelley, McKellar and Zingmark (1986) looked at contributor organism groups in managed and unmanaged South Carolina marshes. They reported the response was an unavoidable, reciprocal and compensatory shift in numbers, biomass and probably species assemblages.

Basis

Gross primary production is the energy entrapped through photosynthesis. Net primary production is gross primary production minus energy used by photosynthetic organisms to maintain life functions (respiration). Soil or water column bacteria, phytoplankton, submerged and floating aquatic vegetation, and emergent vegetation (roots as well as stems and leaves) all contribute to gross and net primary productivity of marsh systems, whether or not the marsh in question is managed.

How does management affect primary production? The question

could equally well be asked in two parts: 1) can management enhance primary production, and if so 2) can it enhance it enough to offset erosion?

Thus, the answer to the first part of the question is a qualified yes. Managers have traditionally emphasized adjusting environmental conditions to increase the production of plant biomass by the aquatic, especially submerged aquatic, and emergent plants of targeted marshes. Managers can point to instances when the production of aquatic and emergent plants increased as intended. In those instances, managers have successfully increased the production of those contributing sources. But there is more to the answer.

Fairly comprehensive studies of primary productivity in managed and unmanaged South Carolina coastal, tidal marshes may be insightful and can serve as a model. Kelley and Porcher (1986) examined macrophyte productivity, Marshall and McKellar (1986) examined aquatic community metabolism and Zingmark (1986) examined production of the microbenthic algae. Kelley, McKellar and Zingmark (1986) then presented a summary and comparison of productivity in managed and unmanaged areas. They concluded that the overall average production in grams/meter was nearly identical in managed and unmanaged areas. They reached: "....two general conclusions based upon these pooled comparisons....(1) impoundment system productivity is quantitatively similar to tidal marsh system productivity at Cat Island and at some other locations along the East Coast of the United States; and (2) the contribution of aquatic community (benthic microalgae, phytoplankton, and submerged macrophytes) to system productivity is greater in impoundments than in tidal marsh and has compensated for the lower productivity of some impoundment macrophyte species" (Kelley, McKellar and Zingmark, 1986). At this time those findings might be as good as any other representation of how primary productivity is affected in managed Louisiana marshes.

Now to the second part of the question...can enhanced productivity reverse erosion (i.e., actual marsh gain). The early answer appears to be maybe in some site-specific cases, but probably not as a general rule.

As an example, Nyman, Chabreck and Linscombe (1990) state:

> "Marsh Island has few canals; therefore, marsh loss resulted primarily from natural processes. Weirs may have different effects under different hydrologic conditions; additional studies are needed before generalizations regarding weirs and marsh loss can be made",

a conclusion that reinforces the observation made by Nyman et al. (1994) that marsh loss mechanisms can vary spatially even within small geographic areas.

4.3.5.1.1. Marsh Microorganisms

Largely summarized from Day et al. 1989.

Marsh microorganism are generally poorly studied (Day et al. 1989; Mitsch and Gosselink, 1993). Although we know something about what they do, for example that they have a role in nutrient cycles, comparatively little is known about what species is doing what.

Marsh microorganisms are involved with mediating nutrient dynamics and nutrient and energy cycling. As a group bacteria are capable of converting inorganic materials into several different forms that once converted become available for uptake by other biological forms. Bacteria can themselves incorporate inorganic materials into organic (carbon-based) substances. But other kinds of bacteria, along with fungi and viruses, can do the reverse....initiate and accelerate the break down of organic matter into constituent parts for repackaging and recycling within the marsh system. Fungi begin mechanically breaking down plant materials almost as soon as plants die, almost immediately rendering the newly-exposed surfaces susceptible to the action of associated bacteria. Those very same bacteria and fungi serve as food for species of protozoans and zooplankton.

If turbidity levels reduce light penetration, low or no oxygen may be available from photosynthesis dictating the predominance of anaerobic microbiotic activity. How fast water is exchanged, relative to nutrient concentrations and exposure time of organic matter to microbial activity with a given marsh setting, can influence marsh dynamics. For example, if the microbially-mediated break down of some plant or part of a plant takes several months but flows are elevated or exchange times are shortened, incompletely "digested" material is exported from the marsh. Also, if flows or exchange times are interrupted long enough, too little or no flushing of toxic biometabolites occurs, stressing the marsh system.

Management of water levels and water chemistry can directly impact microbiological communities of marsh soil and the water column. Because management of water levels and water chemistry are and will continue to be effective management tools, differences between the microbiology of managed and unmanaged coastal Louisiana marshes can be expected to occur. Characterizations of what those differences are and

their implications are not fully developed.

4.3.5.1.2. Phytoplankton

Summarized from Day et al. 1989.

Phytoplankton are single cell, photosynthetic plants. Unattached forms of algae in the water column, they move where water moves. Phytoplankton, like other plants, convert inorganic carbon (as carbon dioxide gas) and dissolved nutrients (e.g., nitrogen, iron, phosphorous, silicon) into living tissue. They are a major food source for animals in the water column (e.g., zooplankton, plankton-eating fish) and sediments.

Phytoplankton may exhibit seasonal differences and spatial patterns. Nutrient, salinity and turbidity levels and circulations patterns can be quite different over small distances within any given marsh. Locally, differences are, therefore, likely to be quite great. Seasonal differences may be notable at the regional and coastal scales.

Because they are photosynthetic, light is a major controlling factor. Photosynthetic activity is related to the amount and frequency of light waves. Above or below species-specific thresholds, photosynthetic activity stops or is inhibited. Thus, turbidity levels that reduce or preclude light from penetrating throughout the water column, whether of marsh ponds or over the marsh during flooding situations, influence the rate of photosynthesis. However, even a turbid water column, if sufficiently mixed, can sustain photosynthetic, if at a reduced rate.

A shortage of any one of the inorganic nutrients would limit phytoplankton. Nitrogen (as ammonium) is potentially more limiting than phosphorous to phytoplankton and competition with bacteria for inorganic forms of these nutrients can occur (Day et al., 1989).

Photosynthesis consists of a series of biochemical reactions. Therefore, temperatures can influence the rate at which those reactions occur. Each species has a specific maximum temperature beyond which biological activity diminishes. In general that upper range extends from a low 50 degrees Fahrenheit to a high near 90-100 degrees Fahrenheit (Day et al., 1989). Temperature optima for local phytoplankton populations reflect the local temperature regime and shifts in response to temperature changes can occur within about a day. For example, during winter phytoplankton species differ from those in summer and phytoplankton activity is lower.

The amount of organic matter produced within a marsh in the form of phytoplankton can equal and may exceed the amount of organic matter in emergent and aquatic plants.

Management affects nutrient, salinity and turbidity dynamics and circulation patterns, all of which influence phytoplankton. And, these attributes can differ over small distances. Phytoplankton differences between and within managed areas should be expected. Characterizations of what those differences are and their implications are not fully developed.

4.3.5.1.3. Emergent Vegetation

Summary

The response of this significant attribute has been, is and is likely to be the focus of many HM efforts. As such, it will continue to be targeted as a stepping stone to achieving other biological management objectives (e.g., waterfowl habitat improvement by increasing the extent of seed producing emergent or even more importantly the volume of submerged aquatic vegetation, management, arresting marsh losses).

Some more modern HM efforts intentionally attempt to control how specific emergent plant species respond to adjustments of the frequency and amplitude of water level and water chemistry oscillations. Such efforts are often intended to forestall or slow, stop or reverse marsh losses.

As discussed earlier, if a management effort involves reducing water elevations within the soil profile to several inches below the surface from early spring to as late as early summer, some emergent marsh plants produce more above and below ground plant material, and some emergent marsh plant species are favored over others. Eliminating constraining growth conditions (stresses caused by prolonged soil flooding) for targeted species are cited as reasons for invigorated plant growth responses.

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without manipulating this significant attribute. The water control structures used to indirectly influence this significant attribute may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users (e.g., reduced access).

Basis

Emergent marsh vegetation, whether growing on uneroded, native soils or eroded soils exposed through management efforts, convert inorganic carbon and nutrients into organic compounds and materials, dissipate erosive wave energies, contribute plant biomass to the marsh environment, are involved in marsh nutrient and energy flows, facilitate sediment deposition/retention, serve as food for some marsh dependent species, provide shelter for some transient as well as resident aquatic organisms, mediate physico-chemical water conditions, and serve as the physical framework upon and within which an associated community occurs.

Managers interested in forestalling or attempting to slow, stop or reverse marsh losses may attempt to induce physico-chemical soil and hydrologic conditions that foster the increased production, accumulation and retention of organic matter by emergent plant species. Any such additional organic matter is presumed to supplement whatever mineral sediments enter and are retained. The combination of greater organic matter production and enhanced mineral/organic sediment retention is assumed to compensate, typically to some unknown degree, for subsidence and sea level rise.

To accelerate the growth of marsh grasses or foster the retention of sediments, managers can attempt periodic, repetitive reductions of water levels within the marsh soil profile/exposure of uneroded marsh substrates (via AMM), dampen environmental extremes (via PMM) or emulate (via HR) some historic, possibly natural, hydrology. Strategically timed introductions of fresher, sediment carrying water can and in some cases have been incorporated into management programs. The intended result is to invigorate overall plant growth by creating soil conditions that are even more conducive than normal to root growth and provide sites for plant colonization.

Depending upon the plant species targeted for management, flooding either too often or too infrequently can be stressful/lethal. Leaves, and sometimes stems, and for a few species the roots, serve as the surfaces for the exchange of atmospheric gasses. The leaves and stems intercept sunlight. The atmospheric gasses and sunlight are essential to plant growth (Kozlowski 1984).

Depending upon the targeted species, too much salinity can be stressful/lethal. Accordingly, managers must often attempt to maintain water depths <u>and</u> salinity levels, in and over an uneroded marsh soil, below levels that if exceeded would not support the sustained, vigorous growth and

reproduction of the desired emergent marsh grasses.

Not all marsh plants grow on all marsh soils (see Appendix A). For example, growth of a very common emergent plant species of brackish marshes, which is also the single most important emergent plant species of saline marshes (oyster grass, Spartina alterniflora), has been correlated with marsh soils that have more than a minimum amount of mineral material (Pezeshki et al. 1989). Fresher marsh plant species tend to require less mineral sediment content.

The effects of such actions also influence the microbial and phytoplankton community components, with corresponding effects on nutrient and energy dynamics and the structure and composition of marsh soils. Because manipulations of water regimes diminish or occasionally seasonally eliminate communications between and often occur out of phase with the natural tidal dynamics, differences in several attributes of the plant and other significant attributes within managed and unmanaged areas have been observed and measured (e.g., Sweeney et al. 1990).

4.3.5.1.3.1. Emergent Vegetation On Native, Uneroded Soils

Summary

The effects of traditional management efforts on this significant attribute were seldom specifically documented. Today, those effects are often inferred from available information sources as well as stipulated as a goal relative to addressing marsh losses.

Management proposals that entail intentionally controlling some or many of the influential physico-chemical attributes will apparently be relied upon (see CWPPRA) to forestall, slow, stop or reverse historic or on-going marsh losses. To succeed, managers must attempt to maintain water depths, salinity levels, and water movement patterns and velocities, in and over uneroded marsh soils, at or below levels that support the sustained, invigorated growth and reproduction of emergent marsh grasses and retention of produced organic plant material.

Basis

Management has been able to modify conditions in some cases enough to allow the growth and expansion of emergent species on native soils. And, management has been shown to be capable of invigorating this significant attribute. But the record is inconclusive when is comes to answering the question to what degree can management be counted on to predictably slow, stop or reverse marsh losses (Sweeney,

1990; Broussard, Undated).

4.3.5.1.3.2. On Eroded But Exposable Soils

Summary

This significant attribute can only be expressed in semi-impoundments subjected to AMM or in areas subjected to HR efforts that mimic historic management conditions encompassing water levels reductions. Managers may attempt reductions of water levels to expose eroded marsh substrates to invigorate plant growth, stimulate root growth and to provide sites for plant colonization (either apparent or actual marsh gains). Such intensive management efforts have the greatest potential to impact most of the other biologically significant attributes, some beneficially and others adversely, most unavoidably.

Basis

Vegetation induced to grow on exposable soils assists in reducing erosion of any remaining vegetation on native soils. When the targeted area is devoid of native vegetation, this kind of management could be the only way to reestablish emergent vegetation.

Required water level reductions may be attempted as frequently as once each year for several successive years or as infrequently as once in every three to five years. Meteorological and climatic conditions more often than not dictate the frequency, duration and degree of water level reduction achieved in any one year (Cowan et al. 1988).

The emergent plant species that are induced to grow on exposable, eroded soils (apparent marsh gain) can be different from those growing on the uneroded marsh soils. Annuals typically occur on the exposed, eroded soils. When and how long eroded soils are exposed can influence the composition of the plants induced to grow.

Depending upon the species, flooding either too soon after germination/growth begins or too deeply can be stressful/lethal. Accordingly, managers must consider maintaining water depths, in and over an eroded marsh soil, for a period that will induce and support the hopefully vigorous growth and possible reproduction of emergent marsh grasses.

This response to management is more likely to arise as communications between managed and unmanaged areas are reduced. Efforts to revegetate exposable, recently eroded or historically eroded marsh surfaces have occurred in the

past and are likely to continue into the future but more as an effort to slow, stop or reverse marsh loss. Because this effort requires invoking the tightest controls on the hydrology of the managed area, the consequences and ecological implications are probably similar to in form but more intensive than those that occur when attempts are made to stimulate/invigorate aquatic vegetation within managed areas.

4.3.5.1.4. Aquatic Vegetation

Summary

Increasing the amount and extent of aquatic vegetation has been positively correlated with increasing water clarity (reductions in turbidity to facilitate germination and growth), stabilized water depths (especially during late-summer thought winter to forestall dehydrating conditions), and reduction of salinity events exceeding 15 ppt (to avoid stressful/lethal conditions). Success can be characterized as moderate to good. However, the response may be heightened if management can reduce water levels enough to consolidate otherwise poor pond soils, resulting in turbidly reductions and improved root zone soil structure upon reflooding.

This significant attribute has been intentionally targeted for management and probably will be targeted in the future. It unquestionably will remain a prominent feature of management efforts intent upon improving conditions for overwintering waterfowl. However, more recently it has and likely will continue to be a stipulated feature of AMM and HR management efforts intent upon addressing marsh losses. It's role in organic matter production/sediment retention characteristics and wave stilling attributes appears irresistible. Discerning how much additional benefits predictably arise from water level reductions will probably remain the subject of speculation because of the meteorological and climatic uncertainties that affect the frequency and duration of water level reductions (Cowan et al. 1988).

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without intentionally manipulating this significant attribute. The water control structures unavoidably required to indirectly influence this significant attribute may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users (e.g., reduced access).

Basis

Floating and submerged aquatic vegetation convert inorganic carbon and nutrients into organic compounds and materials, dissipate wave energies, contribute plant biomass to the marsh environment, are involved in marsh nutrient and energy flows, facilitate sediment deposition/retention, serve as food for some marsh dependent species (Chamberlain 1959, Chabreck et al. 1985), provide shelter for some transient as well as resident aquatic organisms, mediate physico-chemical water conditions, and serve as the physical framework upon and within which an associated animal community occurs.

Many of the plants species managers are concerned with grow only in shallow water and are excellent waterfowl food. In marshes influenced by salinity, widgeon grass (Ruppia maritima) is the single most important submerged aquatic species in ponds. Stable water levels, firm soils, low turbidity levels and salinity levels that don't exceed 15 to 18 parts per thousand are ideal (Joanen and Glasgow 1965) for Ruppia.

These plants are adapted to exchanging gasses with their leaves, stems and roots completely submerged or positioned just below the waters surface even when the water is murky and little sunlight is available to drive photosynthesis (Kozlowski 1984). Other plants in this group are adapted to exchanging gasses and photosynthesizing in leaves and stems that float on or extend above the water surface.

These plant groups are dependent upon somewhat stable water levels. Typically, exposure of these plants to the atmosphere and cooler temperatures during the fall and winter months due to naturally occurring water level changes often proves lethal.

Managers of marshes undertake efforts to reduce salinity, turbidity and/or water level fluctuations to levels that are not stressful or lethal. If successful, conditions arise that are conducive to the expansion/invigorated growth of submerged aquatics (Chabreck 1994). Management options include excluding or reducing the amount of higher salinity water from the managed area (salinity thresholds), and periodically reducing water levels to consolidate sediments to reduce turbidity. Elevated water temperatures can suppress growth and physiological function. Introducing cooler water, from rainfall or from areas outside the managed area, is a corrective action. However, the source of the cooler water may be the unmanaged estuary where ambient seasonal salinities exceed the salinity threshold established for the managed area.

Unintended effects include influences on the microbial and phytoplankton community components, with corresponding effects on nutrient and energy dynamics. Because water management regimes are often very similar between managed areas, management's effects on nutrient dynamics should be a function of the total area involved in management, sources of microbial communities and how the chemistry of the involved soils and how the phytoplankton and microbial community components respond to management.

4.3.5.2. Higher Levels of Production

Unicellular zooplankton (organisms that eat phytoplankton and bacteria), and the organism that comprise the multicellular marsh dependent organisms {e.g., polycheate worms, oysters, amphipods, shrimps, fishes, reptiles, amphibians, birds and mammals) all contribute to the secondary productivity of marsh systems, whether or not the marsh in question is managed.

Summary

Traditionally, management focused on increasing the harvest of a very few species (i.e., furbearers, alligators and waterfowl) that contribute to secondary production. Little has changed.

Furbearers and alligators are year-round residents. Targeted waterfowl species are overwhelmingly winter migratory resident.

Modern HM efforts tend to focus on amending conditions that encourage increased emergent and aquatic plant production to forestall, slow, stop or reverse marsh loss. The marsh dependent animal community in targeted managed areas change in response. Predictions of how the dependent marsh animal groups respond are largely conceptual. Except for the traditionally targeted animal species, documentation is scarce. Thus, they serve as surrogates for predicting secondary production.

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without manipulating any or these significant attributes. The water control structures unavoidably required to indirectly influence this significant attribute may intentionally or coincidentally: a) further socioeconomic objectives of the landowner/leaseholder (e.g., trespass control), or b) create socioeconomic problems for resource users (e.g., reduced access).

Basis

Managers can point to instances when their efforts have achieved demonstrable success in increasing the production of aquatic and emergent plants by undertaking actions to stabilizing water levels, reduce water velocities, dampen tidal action and suppress salinity.

Most papers describe observations or relationships. Others report on how statistically certain a studied relationship may be, and/or infer biological relationships. Nearly all conclude with explanations or management implications of the relationship.

Individually, many very interesting associations have been insightfully documented to various degrees. Collectively, however, we have been unable to find any single study or collection of studies of Louisiana coastal marshes that rigorously measured the effects of management on the range of species that contribute to secondary production of managed marshes or compared those attributes against unmanaged Louisiana marshes. Therefore, the effect of management on secondary productivity of Louisiana managed marshes in general or any specific managed marsh remains to be demonstrated. Thus, studies of components that contribute to secondary productivity from managed and unmanaged tidal South Carolina marshes may be insightful.

Many of the profiles of biologic resources that follow were derived and summarized from Day et al. (1989) and Mitsch and Gosselink (1993).

4.3.5.2.1. Zooplankton

Summary

Zooplankton are "transfer agents." They concentrate nutrients and energy when larger forms of plankton prey upon and may influence the population size of smaller zooplanktors. Zooplankton are food for larger species, thereby serving as consumable nutrient and energy particles. Because of their higher numbers and feeding rates, short life spans and movement patterns intimately linked to water movements, zooplankton play a role in nutrient, especially nitrogen, dynamics. Some zooplanktors are a dispersal form in which species (e.g., shrimp) move between the marsh and nearshore waters. A very few species of this group are of economic importance (e.g., shrimp).

Temperature, food, predation and salinity are purported to be the main factors influencing zooplankton. Zooplankton occur over wide ranges of temperature and salinity.

Tolerances to temperature and salinity encompassed by the diverse planktonic community that apparently characterizes Louisiana's coastal marshes appear capable of offsetting single species reductions due to salinity sensitivity or temperature.

Basis

Zooplankton are small organisms. They are classified by size. The biggest forms are about 0.05 inches long. The smallest forms are microscopic and unicellular. The movements of plankton are controlled by the movements of the tides and currents. Some species, generally the larger ones, can swim weakly, jellyfish being an example. Immature stages of marsh dependent species are also classified as plankton. Benthic worms, shrimp, crabs and many fish species are examples.

Of the forms that spend their entire life as plankton, immature individuals of a single copepod species (Acartia tonsa) tend to predominate. That numerical dominance persists throughout the year with larval numbers tending to peak in the spring in Barataria Bay, Louisiana. The smallest-sized plankton group consists of many more species and are significantly more abundant, even in Terrebonne Bay, Louisiana.

In Barataria Bay A. tonsa occurred in waters with temperatures between 40 and in excess of 90 degrees Fahrenheit and with salinity that ranged from near zero to 30 pat. In Louisiana's warmer waters, zooplankton can be expected to exhibit several generations each year but temperature probably does not influence species composition. Zooplanktors that eat plant material probably are not food limited, considering the amount of detritus that is available but predatory zooplanktors may be food limited.

If quantitative studies comparing the structure and function of the zooplankton communities in managed and unmanaged Louisiana marshes have been performed, they are not readily retrievable. Taniguchi's (1986) study of managed and unmanaged marshes in South Carolina is, therefore, indirectly insightful. He measured changes that occurred in the numbers of several zooplanktor populations, temperature and salinity over more than a year in managed marshes and in an adjacent tidal creek in unmanaged marsh. He recorded unexplained differences between ponds. However, he also recorded population compositions and standing crop densities in ponds that were statistically similar to and occasionally significantly higher than what he recorded in the creek. He observed that within several weeks zooplankton population densities returned to prewater level drawdown densities. He

concluded that management of ponds does not separate planktonic fish larvae and their food and that differences between managed ponds and unmanaged marshes tended to be short term.

4.3.5.2.2. Benthos

Summary

Benthos (Appendix R) remain one of the most understudied components of marshes (Conner and Day 1987; Gaston and Nasci 1988) for several reasons. However, average grain size, percent sand, silt and clay, and organic matter content of the sediments, salinity and water levels relative to marsh and pond soils influence the distribution and abundance of these species in the shallower waters of coastal marshes (Conner and Day 1987). Thus, hydrologically managed marshes can be expected to exhibit measurable compensatory relationships between each other and unmanaged areas for this significant attribute.

Conner and Day (1987) report on the benthic community from Barataria Bay (Basin 4), "....the subject of more continuous study than that of any other locality in the Gulf of Mexico...." The functional linkages between benthos and other significant attributes can be overwhelmingly complex. That has made them difficult and expensive to quantify. Thus, the consequences of HM actions that impact this attribute, or its influencing physico-chemical environment, are incompletely documented, must be inferred from professional insight, and thus could be considered largely speculative.

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without appreciably affecting this significant attribute. Water control structures unavoidably required to influence other significant attributes can be expected to have unintentional but consequent and often unappreciated impacts to this significant attribute.

Basis

Benthos is an inclusive term that can refer collectively to the plants, animals and substrates that are the bottom of ponds and the medium in which marsh plants are rooted. Earlier in this EIS, marsh and pond soils, bacteria, fungi and other forms were themselves identified as significant attributes. Therefore, benthos specifically refers to the organisms that live within or on pond and marsh soils.

Organisms that live within or on marsh/pond soils influenced by changing water levels must contend with the physical and chemical differences that arise from water level fluctuations on several time scales, (e.g., daily through seasonal). Seasonal changes in water chemistry are influential factors affecting distribution and abundance.

Stabilizing water levels or water level drawdowns are typical management options. Both are typically subject to intentional manipulations but to different degrees. Accordingly, water flow patterns over and through the sediment profile may change the oxygen profile in the soil, and may also amend the soil structure. Thus, areas managed with water level drawdowns are likely to exhibit difference from areas where water levels are stabilized.

Textbook treatments (e.g., Day et al., 1989; Mitsch and Gosselink, 1993) with discussions of and examples from Louisiana, supplemented with studies of managed South Carolina coastal marshes (Zingmark 1986, Coull 1986, Wenner 1986), are illustrative of the universality of the responses and relationships. Their response to management is also sparsely reported (Christian, Bancroft and Wiebe 1978; Marshall and McKellar 1986; Taniguchi 1986; Zingmark 1986), but appears that this marsh community component exhibits a compensatory relationship between species in managed and unmanaged areas.

Omni (1986) concluded that,

> "Utilization of the impoundments by target (shrimp and crabs) organisms was dependent on water exchange between Chaney Creek and the impoundments to provide access to the impounded area.....The degree to which a particular species was able to inhabit the impounded areas depended upon the timing of recruitment of that species and periods of water exchange between Chaney Creek and the impoundments."

Wenner (1986a) focused on characterizing decapod crustaceans from natural and impounded wetland areas. To facilitate his comparison, he pooled data from impoundments. By using pooled data, he statistically equated impoundments, despite the loss of hydrologic integrity on several ponds on separate occasions and some differences in water management regimes between ponds. In effect he measured something more like a "net" response over a range of natural and man-made situations managers of impoundments might encounter. In that unintended context, he reported that managed and unmanaged areas were similar in many respects (species composition, temporal patterning), but also exhibited differences. Differences suggested by his data were that

structures and management regimes imposed access and retention selectivities of blue crabs and Penaeus shrimp.

These same conclusions would seem to apply to some degree fairly well to managed Louisiana marshes (see Fish, immediately following).

4.3.5.2.3. Fish

Despite the cultural implications and economic overtones of fisheries, never has the improvement of fisheries habitat been the single or even a stipulated purpose for any HM effort submitted for a permit. Proponents have credited management with indirectly improving the quality of and/or prolonging the existence of fishery habitat in managed areas. Opponents disagree based on reduced access.

Summary (Largely summarized from Day et al. 1989)

Ecologically, fish can affect nutrient and energy dynamics. Their sheer numbers can influence the species structure of the benthos. Fish are a reservoir of nutrients and energy. Fish also redistribute nutrients and energy within the marsh as well as between marsh types, adjoining aquatic environments and to terrestrial settings as fertilizer. Many fish are recreationally and commercially important, and as such have social, economic and cultural importance directly to man.

Estimates of production of fish in the open estuary and marsh are generally lacking due to the complex life cycles and movement patterns of the component species. Surrogates for productivity are standing crop and catch per unit effort. Perret et al. (1993) present brief profiles of the more important commercial species.

This significant attribute probably has been, is and likely will continue to be affected, often adversely (especially estuarine migrant species), relative to efforts undertaken to achieve other biological management objectives (e.g., waterfowl habitat improvement, addressing marsh loss), particularly in salt influenced marsh types. Efforts to reduce or minimize adverse impacts to those species in those situations are undertaken, but in many cases only in so far as they don't compromise the principal objective(s) of HM efforts.

Some socioeconomic management objectives (e.g., protection of property or mineral rights) can be achieved without appreciably affecting this significant attribute. However, water control structures unavoidably required to influence other significant attributes pursuant to other management

objectives unquestionably have consequent and often significant impacts on measurable characteristics of this significant attribute as well as the direction and ease with which man moves within and between hydrologically managed areas. The collective socioeconomic implications are poorly documented.

Basis

The term fish, as used in this EIS, encompasses a wide variety of actively swimming aquatic life forms. There are several ways to profile this extremely diverse collection organism. One functional way is to focus on where they are in the water column, what they eat and whether they exhibit migratory movements linked to reproduction. The reader is requested to read Appendix E for more information.

At no time during any year are fish absent from Louisiana's coastal marshes. Thus, the effects of management on fish have been the source of a great deal of research during the last decade here in Louisiana (see Appendixes B and E). There are really three questions: 1) how do fisheries organisms respond to management structures; 2) what is the effect of that response on production within managed areas; and, 3) what, if any, are the biologic and socioeconomic effects of management in general.

Herke (1979, 1971, 1967) compiled evidence that one particular management structure (a fixed-crest weir in a semi-impoundment - PMM) unavoidably influenced the structure of the estuarine-migratory fisheries resources within the targeted marsh relative to an unmanaged control marsh (see also Appendix B). Relying heavily upon designed manipulative studies in a brackish marsh in the Chenier plain, convincing evidence emerged that the production of the fishery community (Herke et at 1992, Rogers, Herke and Knudsen 1987) underwent numerically significant reductions and the community exhibited other temporal and size differences (Rogers and Herke 1985 a,b). Changes arose within a year because several fishery species, including several commercially important species, encountered reduced opportunities to enter and leave the managed area in response to environmental cues such as frontal passage, and water temperature and salinity changes (Herke, Wengert and LaGory 1987).

Other water control structure designs evidenced less dramatic responses but still induced measurable differences (Rogers 1989; Rogers, Herke and Knudsen 1987, 1992). The water control structures were concluded to be a physical as well as a behavioral impedance to some species.

Paille et al. (1989) examined how white shrimp production responded to structures and based upon their data speculated about the validity of a number of hypothesis that attempt to explain how weirs and other control structures reduce recruitment of estuarine organism. They concluded that more study is required to discern what the relationship is between water control structures, recruitment and production.

The response of estuarine-migrant fish species within salinity-influenced managed semi-impoundments reported by Herke is not unique. Perry (1981) and Perry and Joanen (1986) report finding larger individual shrimp but generally reduced numbers and a reduced overall biomass, similar to the response reported by Herke in several of his studies. Similar patterns were observed for decapod crustaceans by Olmi (1986), and fish in general by Wenner et al. (1986) in a managed semi-impoundment in South Carolina managed with a flapgated culvert and variable-crest weir assembly.

Induced differences associated with the vertical-slotted weir were about half the differences associated with the traditional fixed-crest weir (Rogers, Herke and Knudsen 1987). Rogers (1989) reported measurable differences across a rock weir located in a Delta marsh were similar to conditions behind a slotted weir.

Studies on some (Rogers, Herke & Knudsen 1992) but not all the kinds and combinations of water control structures have yet to be performed. However, physico-chemical conditions and the composition of the fish community within a Delta marsh managed with fixed-crest weirs and a variable-crest weir fitted with a flapgated culvert also diverged measurably from the prevailing condition in the surrounding unmanaged portions of the marsh (Simmering, Woodard and Clark 1989; Rogers and Rogers 1990).

Based upon Louisiana studies, longer-term data collected from several other managed Louisiana Chenier marshes (Konikoff and Hoese 1989, Hoese and Konikoff 1990), as well as studies of managed South Carolina (Olmi 1986, Wenner 1986, Wenner et al. 1986) and a New England salt marsh (Sinicrope et al. 1990), many different kinds of structures used for management in different parts of the country must be presumed to universally and unavoidably restrict the movements of a wide variety of commercial and noncommercial fishery species within as well as between managed and unmanaged marshes.

As for the effects of HM on fish production, management that uses structures, semi-impoundments, and/or causes water levels to recede from the marsh edge for longer or prolonged

periods would apparently disrupt the temporal and spatial relationships fish exhibited relative to nearby shallow water and the marsh edge (Peterson and Turner 1994). The short-term net effect would be a reduction of habitat diversity and accessibility, especially for resident species that use the water over the marsh surface for life functions (Rakocinski et al. 1992). Within some managed areas, apparently this predictably produces a compensatory adjustment, characterized by: 1) increased numbers and overall biomass of some species (predominantly full-time marsh residents); and, 2) decreased numbers and overall biomass of other species (particularly estuarine migratory species). The shift can be attributed to: 1) impeded access of many estuarine migrant species; and 2) expansion of marsh resident species as physico-chemical conditions are induced to change within managed areas.

Hoese and Konikoff (1990 a,b), and Hoese et al. (1990), have also been recently active Louisiana investigators interested in the fish communities in managed (e.g. semi-impoundments) and unmanaged areas. Hoese and Konikoff (1995, galley proof), by scrutinizing existing fishery data sets, hypothesized that differences in fish communities induced by management and structures could be eliminated by a natural event. Specifically, when rising or elevated water levels compromise the hydrologic integrity of a managed area, species otherwise excluded from the managed area are reintroduced from the surrounding, unmanaged marshes. If their hypothesis proves to be valid, induced physico-chemical differences, regardless of their magnitude, might also be erased/reversed. If so, a semi-impounded marsh could exhibit a cycle of repetitive biological and physico-chemical divergences on an unknown frequency. No comparable evidence exists for marshes subjected to HR.

Montague et al. (1987, page 751) offered the following conclusion after reviewing the pertinent literature:

> "*Estuarine organisms that benefit most from the perhaps equal or greater nutrition present in managed impounded marshes are those that can enter the impoundment and survive there while feeding. The most significant question concerning the effect of impoundment on production of estuarine fish and shellfish is not whether the net transport of bulk organic matter and plant nutrients is altered, but rather whether estuarine fish and shellfish can enter, grow, and leave impounded marshes in a way that is compatible with estuarine fish management objectives.*"

Additionally, Tom Minello at EPA's Structural Marsh Management Workshop (1994) stated that the fishery resources

have been increasing due to the export of detritus from eroding marshes and that a collapse of the fishery resource is possible if marsh losses continue unabated.

4.3.5.2.4. Wildlife

> "*Most wetland management is directed toward waterfowl, with the goal being to improve production, to aid during migration and winter, or to do both....Generally, other wetland wildlife species are managed incidental to waterfowl.*" Payne (1992, page 4)

The typical design, operation and permit history of most management efforts targeting wildlife species: 1) unavoidably impacts a wide range of significant attributes of Louisiana's coastal marshes; and, 2) suggests the possibility that many such efforts could have been/were really undertaken to address other socioeconomic interests (e.g., protection of property rights, mineral rights).

The socioeconomics derived from the response of specifically targeted species or species groups to HM efforts have been quite often stipulated as a primary (e.g., waterfowl) or complimentary and companion, or secondary (e.g., furbearers) reason(s) for initiating some HM efforts. Eco-tourism is one such consequence that has recently arisen but is little studied.

Creating, prolonging or improving the life requisite conditions for wildlife species requires manipulating physico-chemical as well as biological attributes of marshes. Managers typically attempt to modify the habitat to: 1) produce more and/or better quality furs; 2) produce more and/or larger alligators; or 3) make it more attractive to overwintering, migratory waterfowl than many other areas they could potentially use in the general area.

Such efforts have generally met with mixed or better success. Impacts to the non-targeted significant attributes (to include non-game species) within the managed and neighboring marshes can be conceptualized but have gone unquantified.

Ecologically, wildlife are involved with and can affect nutrient and energy dynamics. Their numbers, size, mobility and dietary requirements can influence the structure of any marsh. Some, such as the native muskrat (Ondontra zibethicus), American alligator (Alligator mississipiensis), and some waterfowl species (snow geese - Chen hyperborea), but more particularly the exotic nutria (Myocastor coypus), have exhibited the biological capacity to temporarily (muskrat) and perhaps permanently (nutria, geese, alligator)

convert vegetated marshes into shallow open water areas. Wildlife consume, store and redistribute nutrients and energy. Depending upon species, that redistribution can be within a marsh (e.g., small mammals), between marsh types (e.g., resident waterfowl), and to other Louisiana marsh and/or terrestrial systems (e.g., deer, wading birds), as well as to terrestrial settings elsewhere in the world (migratory waterfowl). Collectively, several waterfowl and mammalian species and one reptilian species are recreationally and/or commercially important, and as such have social, economic and cultural importance directly to man.

Appendix F is a narrative discussion focusing more on the natural history of many of the more notable marsh dependent species.

4.3.5.2.4.1. Reptiles and Amphibians

Most species are limited to fresh and intermediate marshes with only a few able to inhabit saltier marshes if/when there are areas that provide relief/escape for the saltier water, cover and nesting/resting areas. Accordingly, successful HM often targets reducing salinities to species-specific tolerances. If refugia are present, many species of this group are likely to be indirect beneficiaries of management.

Life history details about individual reptilian and amphibian species in Louisiana's coastal marshes are known in broad terms, most recently addressed by Dundee and Rossman (1989). Additionally, much of the basic information about their general habitat, food requirements, behavior, distribution and abundance is also presented in the popularly published field guides.

Turtles, alligators and snakes are the most prominent reptilian species within Louisiana's coastal marshes. As a group, 33 of the 36 species are expected to commonly occur in fresh and/or intermediate marshes (Brantley, Pers Comm). Most are inclined to be found in proximity to surface geomorphologic features that, depending upon species, provide nest sites, food and/or relief or escape sites from flooding (Platt et al., 1989).

As salinity increases the distribution and abundance of these species decreases rapidly. Based upon their physiological tolerances to salinity, only a comparatively few reptile and amphibian species are adapted to living in the brackish and saline coastal marsh types. However, detailed insight into how individuals or these animal groups in general respond to efforts to manage Louisiana's coastal

marshes is lacking.

The American alligator is a marsh-dependent species with a long, demonstrable history of prominent economic importance. Accordingly, considerably more research, and therefore detailed information, has been collected about the American alligator (Gosselink 1984). Additionally, they received attention because for several years they were a Federally protected species. The Rockefeller Refuge, a facility that is part of the Louisiana refuge system and located in the Chenier region of the state, was where much of the research was done that led to this species's recovery and produced the insight that allows a yearly, statewide harvest of this species as part of the management program. As management efforts often compliment the life requisites of this species but the alligator is seldom the singular target of management, it is often an indirect beneficiary of management.

Pursuant to Louisiana's Department of Wildlife and Fisheries laws, alligators are classed as furbearers. Alligators can occur in all marsh types. However, breeding and nesting occur much or often in intermediate and fresh marshes. Young alligators in fresh marsh consume crawfish. Their young counterparts in intermediate and brackish marshes consume blue-claw crabs (Callinectes sappidus). Adults alligators prey heavily on nutria. The higher levels of salinity in brackish and saline marshes are physiologically stressful. The tidal dynamics and topography of more saline marshes are limiting because of the lack of physiologically palatable water for juveniles and nest sites flood.

See also: 4.3.5.2.5. Marine Mammals and Threatened And Endangered Species

4.3.5.2.4.2. Birds

Summary

Birds, as a group and exclusive of waterfowl, are unintended but indirect beneficiaries of many HM efforts and some past actions of man.

Basis

A narrative discussion focusing more on the natural history of many of the more notable marsh dependent species is presented as Appendix F.

Seasonally migrant and resident bird species are associated with Louisiana's coastal marshes. Wading birds (herons, ibis, spoonbills, wood storks), shorebirds, passerines

(resident-summer/winter and migrants) and waterfowl are four main groups.

The seasonal prominence of shore and other wading birds usage of managed marshes is well documented. Managed marshes are apparently used preferentially because of the water level differences between managed and unmanaged marshes. Managed marshes are used for feeding areas more so than unmanaged areas when water levels in unmanaged areas are high.

Wading birds (a collection of approximately 15 resident/migratory species that comprise this group) exhibit species-specific foraging behaviors over water depths between one and 20 inches. Summer/fall drawdowns can provide areas where food is concentrated. Additionally, they generally prefer isolated groves of trees or shrubs for roosting and/or breeding (rookeries) and require alternate sites for the same purposes. The potential for rookeries to be present at any given project site is acknowledged. Previously issued projects were reviewed and assessed for the presence of rookery sites. Future projects submitted for permit consideration will also be reviewed and assessed for the presence of rookery sights. Therefore, a project-by-project inventory for the potential for rookery sights to occur near or within each and every candidate project is beyond the scope of this PHMEIS.

The approximately 30 species of migratory and wintering shorebird species exhibit species-specific foraging behaviors that encompass wet meadows, exposed mud flats to stable water depths of one to two inches. Management that provides these foraging situations during mid-March through May and again from early July through October can augment natural food levels and increase diversity of shorebird assemblages.

The majority of the approximately 70 passerine species occurring at some time in Louisiana's coastal marshes are opportunistic, associating with vegetation on embankments, cheniers, or exposed mud flats. Thus, management that indirectly invigorates/expands vegetation growing on elevated areas generally improves conditions for most species of this group [especially the migrant neo-tropicals (Olsen and Noble 1976)], while summer/fall drawdowns (a proactive strategy that is very uncommon in the management of coastal Louisiana marshes) that create weedy upper marshes and flats are attractive to wintering sparrows, pipits, meadowlarks, blackbirds, rails and snipe.

See also: 4.3.5.2.5. Marine Mammals and Threatened And Endangered Species

4.3.5.2.4.3. Mammals

Summary

Furbearers have been, are and-are likely to continue to be intended and direct beneficiaries of HM efforts and some past actions of man. The other mammals, as a group (including small game species), and cattle have been, and are likely to continue to be, unintended but indirect beneficiaries of HM efforts and some past actions of man.

Basis

In general, many mammalian species derive some life requisite resources from Louisiana's coastal marsh types. Aquatic mammals include the dolphins, seals and whales. Only the Atlantic bottle-nosed dolphin (Tursiops truncatus) typically occurs in the larger shallow open water bays adjacent to the Gulf where they forage for fish. All others can be recorded as rare or accidental occurrences of species whose habits are oceanic. Whales are similarly characterized.

Species that burrow (e.g., moles) and other insectivorous mammals (e.g., shrews, armadillo - Dasypus novemcentus) occur rarely in Louisiana's coastal marshes but can venture into the marshes that abut embankments, natural ridges or cheniers with enough elevation to provide refuge from daily tidal flooding. The swamp rabbit (Sylvilagus aquaticus) is similarly limited for nesting. Some insect-eating species (e.g., three or four bat species) regularly travel to the fresher marsh types for insect food but also rely upon nearby terrestrial cover types for other life requisites (e.g., Spanish moss in oaks for roosting). Squirrels are like the bats...they associate with marshes more or less indirectly where trees on ridges and cheniers provide food and shelter. Several species of rats and mice, however, forage on insects, invertebrates (e.g., small crabs) and plants in all four marsh types, but are also probably limited by nest sites and refugia from higher flood waters (Bosenberg 1979). Ridges, embankments and cheniers, especially those vegetated with shrubbery, provide sites to construct elevated nests of vegetation, protection from avian predators, fresh water for drinking and relief from all but the highest of tides. The white-tailed deer (Odocoileus virginianus) has been observed in all four marsh types. Population sizes tend to be greater in the fresher marsh types (attributable to a wider variety of higher quality food items) and where natural ridges, cheniers and man-made embankments occur (birthing sites, refugia from flooding).

Cattle grazing occurs in coastal marshes. Although it may benefit some species of butterflies (Ross 1995), improvement of cattle grazing conditions has not been a stipulated reason to manage marshes. However, it could be an indirect effect (especially in the Chenier Basin marshes).

See also: 4.3.5.2.5. Marine Mammals and Threatened And Endangered Species

4.3.5.2.4.4. Furbearers

The focus of the historical interest in Louisiana's coastal marsh mammals has been fur production and harvest. Lowery (1974) dedicates a chapter early in his book to that subject. His book itself is a compendium of anatomical, behavioral, physiological and, to a lesser degree, ecological profiles of Louisiana's mammalian species. O'Neil (1949) published what is generally regarded as the benchmark work on the biology of the muskrat in coastal Louisiana.

Furbearers that are linked with Louisiana's coastal marshes include the opossum (Didelphis virginiana), raccoon (Procyon lotor), mink (Mustela vison), stripped skunk (Mephitis), and river otter (Lutra canadensis). These species are wide-ranging opportunistic omnivores (opossum and raccoon) or carnivores. Except for the otter, their relationship with the marsh is similar to most other mammals, venturing into the marsh to prey on other animals for food. Raccoons and opossums are both trapped commercially but recreational hunting is equally or more prominent.

Nutria and muskrats are the pre-eminent fur bearing species of Louisiana's coastal marshes. The native muskrat occurs in all four marsh types. The introduced nutria rarely if ever occurs in the brackish or saline marsh types. The nutria is physically larger than (sometimes as large as a small beaver) the muskrat. Therefore, the nutria is more prominent in the intermediate and fresh marsh types throughout coastal Louisiana. The two species graze aerial as well as subaerial parts of common emergent marsh plant species, consume aquatic vegetation and also eat small crustaceans and insects.

Olney's three-corner grass (Scripus olneyi), a co-associate of salt meadow grass (Spartina patens) of intermediate and brackish marshes, is particularly important to muskrats. It is by far the preferred food of muskrats in the brackish marsh type and is also used to construct shelters. Where Olney's three-corner grass becomes disproportionately abundant, often as the result of some management practices, muskrat densities often respond by increasing rapidly,

leading to increased grazing and the possible denuding of the marsh (called eat outs). In intermediate and fresh marshes, cattails (Typha sp.) and maidencane (Panicum hemitomon) are heavily used species for food. Diseases, water level fluctuations floods, and food shortages apparently influence population size more so than do trapping or predation.

Nutria were introduced to Louisiana in the 1930's. Despite being trapped heavily for their rich fur since the mid-1940's, they now occur throughout the state's coastal marshes, especially the fresh and intermediate marshes. Like the muskrat, nutria also are prolific breeders. Vegetarians, they eat several pounds of food each day. Thus, when populations rise nutria can induce longer term change in the structure of the marsh. More recent studies suggest the role of nutria in marsh loss may have been underestimated. Alligators and man are their main predators. Populations sizes apparently are reduced by freezing temperatures but freezing temperatures in the coastal marshes are infrequent and unpredictable events. Trapping, or some other population control, may well be necessary to protect marshes.

4.3.5.2.4.5. Waterfowl

Summary

Waterfowl have been and will continue to be a resource of interest. When targeted for management, they benefit indirectly in response to intentional manipulations of selected physico-chemical significant attributes. For the same reason, waterfowl could be indirect beneficiaries of HM efforts that focus on forestalling, slowing, stopping or reversing marsh loss.

A narrative discussion focusing more on the natural history of many of the more notable marsh dependent species is presented as Appendix F.

Basis

Waterfowl is a collective term including both ducks and geese. The focus of management in coastal marshes has been on migratory species of ducks that overwinter in Louisiana's coastal marshes. The bulk of the waterfowl management efforts target dabbling ducks. Water level reductions that expose substrates contribute to producing more luxuriant growths of submerged aquatics and encourage annual vegetation to grow which is also very attractive to waterfowl as foods. The other migratory waterfowl species are untargeted but should be considered coincidental

beneficiaries.

Targeted migratory waterfowl species apparently benefit from stabilized water levels, as evidenced from observations of passively managed areas. What measure of added benefits arise in marshes subjected to water level reductions remains to be documented. However, the effects of management on the native nesting species may not always be positive (Moorman et al. 1991).

Collectively, the following citations speak to the linkage between management and waterfowl: Chamberlain (1959), Carney and Chabreck (1977), Chabreck (1960, 1968, 1976, 1971), Chabreck and Hoffpauer (1962), Chabreck and Nyman (1989), Chabreck et al. (1985), Chabreck et al. (1974), Jemison and Chabreck (1962), and Taylor (1978). However, Chabreck (1960) and Chabreck et al. (1974) appear to be benchmark studies of waterfowl usage of managed marsh impoundments. They also appear to be the principal basis for assumptions about how waterfowl can generally be expected to respond to management efforts.

Management targeting migratory waterfowl typically attempts to: 1) provide a marsh to open water ratio of 70:30, respectively; 2) stabilize pond depths at or below 18 inches; and, 3) induce/foster a luxurious growth of submerged aquatics. These responses are typically monitored, from which the response of waterfowl is inferred. The contribution seeds of emergent plant species could play in waterfowl management efforts (Chamberlain 1959) has apparently diminished in favor of efforts to cultivate aquatic plant foods, possibly due to the new emphasis on addressing marsh losses by stimulating the growth of aquatic vegetation.

According to NOD's permit database, waterfowl is the only class of marsh-dependent animal species for which management has been singularly initiated. Additionally, monitoring of waterfowl is seldom a provision of permit monitoring.

4.3.5.2.5. Marine Mammals and Threatened And Endangered Species

This section addresses species that could be affected by HM efforts in coastal Louisiana and that are either Federally designated as threatened or endangered (pursuant to the Endangered and Threatened Species Act) or are marine mammals protected pursuant to the Marine Mammal Species Protection Act.

We have coordinated with both FWS and NMFS regarding those species, to include information about critical habitats.

Five species of threatened or endangered sea turtles were identified by the NMFS (Mr. Charles Orvitz, personal communication on June 11, 1996; NMFS, Southeast Regional Office, St. Petersburg, Florida) as species that may be impacted by HM activities in coastal Louisiana, they include: the Atlantic green sea turtle (Chelonia mydas), Kemp's ridley sea turtle (Lepidochelys kempii), the loggerhead sea turtle (Caretta caretta), the leatherback sea turtle (Dermochelys coriacea), and the hawksbill sea turtle (Eretmochelys imbricata). There is no proposed or designated critical habitat for these species in Louisiana.

Marine mammals listed by the NMFS as possibly occurring in the Gulf of Mexico near the study area which may be impacted by HM efforts include five species of baleen whales: the right whale (Eubaleana glacialis), sei whale (Balaenopteral borealis), finback whale (Balaenoptera physalus), and the humpback whale (Megaptera novaeangliae); and one species of toothed whale, the sperm whale (Physeter catodon). All whale species are currently listed as endangered. There is no proposed or designated critical habitat for these species in Louisiana. All the whale species are uncommon to rare in the Gulf of Mexico except for the sperm whale (DOI 1994), which is found in deeper waters. None are not likely to be affected, even indirectly, by any of the alternatives studied in detail.

Coordination with the FWS revealed one fish species and four endangered or threatened bird species possibly occurring near the study area which may be impacted by HM efforts. Those species are the Gulf sturgeon (Acipenser oxyrinchus desotoi), southern bald eagle (Haliaeetus leucocephalus), brown pelican (Pelecanus occidentalis), Arctic peregrine falcon (Falco pereginus tundrius), and the piping plover (Charadrius melodus).

The Louisiana black bear (Ursus americanus americanus) is the only threatened or endangered terrestrial mammal possibly occurring near the study area.

The inclusion in this F-PHMEIS of reference and discussion of Federally protected species does not relieve the NOD from subsequent coordination with the FWS and the for individual proposed HM projects, be they candidate CWPPRA HM projects, projects proposed from other sources, or even previously permitted actions. During coordination, specific threatened or endangered species which may be potentially impacted by the proposed project/permitted project would be specifically addressed in more detail.

The readily retrievable literature largely consists of profiling the biology/ecology of these species. Thus, the

response of these species to HM efforts most often must be inferred. T = Threatened E = Endangered

What follows are summaries derived from individual species narratives presented as Appendix G.

4.3.5.2.5.1. Fish

Gulf sturgeon (T)-

The Gulf sturgeon was virtually extirpated throughout its range at the turn of the 20th century. Overexploitation, damming of rivers and other forms of habitat destruction, incidental catch, and water quality deterioration are listed as some of the causes of their decline.

This andromomous fish inhabits marine waters of the central and eastern Gulf of Mexico south to Florida Bay; and occurs in most major river systems from the Mississippi River to the Suwannee River, Florida. Gulf sturgeon less than two years old remain in riverine habitats and estuarine areas throughout the year.

Gulf sturgeon consume insect larvae, molluscs, shrimp, isopods, small fish, crabs, amphipods, annelids, lancelets, brachiopods, and vegetable matter. After five or six years of age, Gulf sturgeon begin to feed almost exclusively in marine or estuarine waters during the winter and live off body fat during summer months.

4.3.5.2.5.2. Reptiles

Kemp's Ridley turtle (E)-

The population decline of the Kemp's ridley has been attributed to predation on eggs by humans, other mammals, birds and crabs, as well as the capture of diurnal nesting females. Accidental capture in shrimp trawls has also been cited.

Although this species once nested on beaches from south Texas to southern Mexico, the Kemp's ridley is now known to nest only on the coastline of the Mexican state of Tamaulipas.

Adults of the species occurs mainly in coastal areas of the Gulf of Mexico and northwestern Atlantic Ocean. Little is known of the movements of the post-hatching, planktonic stages within the Gulf. However, juvenile/subadult ridleys in the Gulf typically occupy shallow, coastal regions and may move offshore to deeper warmer water during winter. Post-pelagic stages in the Gulf are commonly found over

crab-rich sandy or muddy bottoms.

Stomach analysis of specimens collected in shrimp trawls off Louisiana includes crabs, gastropods, and clams, as well as mud balls, indicating feeding near a mud bottom in an estuarine or bay area. Jellyfish have also been reported as part of their diet.

The Kemp's ridley tends to concentrate around the mouths of major rivers. Characteristically found in waters of low salinity and high turbidity and organic content, Kemp's ridleys have been collected in Louisiana from Lake Borgne, Barataria and Terrebonne Bays, and near Calcasieu Pass. The highly productive white shrimp-portunid crab beds of Louisiana from Marsh Island to the Mississippi Delta are thought to be the major feeding grounds for subadult and adult ridley.

Loggerhead turtle (T)-

The population decline of loggerheads can be attributed to egg and nestling predation by mammals and birds

The loggerhead is distributed worldwide in temperate and tropical bays and open oceans. Loggerheads probably range all along the Louisiana coast with specimens from Chandeleur Sound, Barataria Bay, and Cameron Parish.

Nesting in the northern Gulf outside of Florida occurs primarily on the Chandeleur Islands and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi and Alabama.

Food of loggerheads consists of molluscs, crabs, shrimp, sea urchins, sponges, squid, basket stars, jellyfish, and even mangrove leaves in the shallows.

Recent capture and telemetry studies of sea turtle movements along the northern Gulf of Mexico showed usage of the nearshore areas near jetties and channels.

Leatherback turtle (T)-

Population decline of this turtle has been attributed to exploitation of eggs and juveniles

The leatherback sea turtle occurs mostly in continental shelf waters and exhibits seasonal fluctuations to the Gulf Stream and other warm water features.

Nesting leatherbacks occur along beaches in Florida, Nicaragua, and islands of the West Indies, however no

nesting has been reported in Louisiana. Leatherbacks have been collected or sighted in Louisiana from Cameron Parish, Atchafalaya Bay, Timbalier Bay, and Chandeleur Sound

These turtles feed primarily on jellyfish and other cnidarians.

Green turtle (T)-

Population decline has been attributed to heavy fishing pressure and human nest predation.

The green turtle has world-wide distribution, concentrated primarily between 35° North and 35° South latitude. Green turtles current status in Louisiana is unknown (USFWS 1990).

Their distribution can be correlated to grassbed distribution, location of nesting beaches, and associated ocean currents. Within Louisiana waters, these turtles probably occur all along the coast and may nest on the Chandeleur Islands.

During their first year of life, green turtles are primarily carnivorous, feeding mainly on invertebrates. As adults they feed almost exclusively on seagrasses growing in shallow water flats, but also feed on invertebrates and carrion.

Hawksbill turtle (E)-

These turtles generally live most of their life in tropical waters such as the warmer parts of the Atlantic Ocean, Gulf of Mexico and the Caribbean Sea (Carr 1952 and Witzell 1983). Florida and Texas are the only states where hawksbills are sighted with any regularity (NMFS and USFWS 1993). Only one record of a hawksbill in Louisiana has been reported from a gillnet catch in Cameron Parish. This supports the general belief that hawksbills are scarce in Louisiana waters.

Hawksbills breed and nest in warm waters between 25° North and 25° South latitude (Rebel 1974).

This species' primary food source is comprised of sponges and other encrusting organisms. Other organisms found in the diet are now believed to be incidental organisms living in association with the sponges which are consumed for food. Adults forage around reefs up to 100 meters in depth and are not usually in shallow waters less than 20 meters in depth. Juveniles forage in shallow waters near the shallowest coral reefs.

4.3.5.2.5.3. Birds

Brown pelican (E)-

Brown pelicans were historically abundant across the entire Louisiana coastal region. Population estimates between 1918 and 1933 ranged from 12,000 to 85,000 birds. Nesting occurred on Isles Demieres, East Timbalier Island, the mud lumps in the Mississippi Delta, Grand Gosier Island, the Chandeleur Chain, North Island adjacent to the chain, and Isle au Pitre.

A sharp decline in nesting was observed between 1958 and 1961. By 1962, no brown pelicans were found nesting in the state and by the mid-1960's, brown pelicans had been extirpated from Louisiana. This sudden and dramatic decline may have been attributable to pesticide poisoning which caused reproductive failure and a direct die-off of adults.

Since 1975 the numbers of brown pelicans in Louisiana have increased. Martin and Lester (1991) reported six breeding colonies in the state in 1990, representing a total of 2,196 adults. Colonies occurred in the Chandeleur Islands, and several other former nesting sites.

Their diet consists entirely of fish, primarily menhaden and mullet, which have been shown to be affected by AMM activities.

Southern bald eagle (T)-

Bald eagles suffered a pronounced population decline between the late 1940's and the 1970's, largely due to reproductive failure caused by pesticide accumulation in their food chain. Electrocution, severe weather, forested habitat loss, human persecution and disturbance, and lead poisoning also took their toll.

Nesting densities of bald eagles have been correlated with adequate prey availability and water body size and productivity. Large shallow open water areas with relatively high rates of fish production are normally located within nesting habitat. A typical nest site would be located in second growth baldcypress-tupelogum swamp with marshes, canals, and water bodies nearby.

Although the bald eagle is an opportunistic feeder, its primary food source is comprised of fish in shallow water areas (Haywood and Ohmart 1986). Carrion is another common component of the diet of these birds (Lowery 1974a). Dominant prey items included freshwater catfish and American coots.

Projects that destroy nest trees or create conditions that would cause birds to abandon nesting efforts would impact this species.

Piping plover (T)-

Hunting of piping plovers in the early 1900's and the destruction of historical nesting sites, have resulted in a dramatic decline in this species' population. The reduction of wintering habitat along the Gulf Coast has largely been due to recreational and commercial development and dune stabilization.

The population of piping plovers which winters on the Gulf of Mexico coast, the same population which nests in the Great Lakes and Northern Great Plains region, is comprised of approximately 1,400 pairs.

The Chandeleur Islands, Timbalier Islands, Isles Demieres, Atchafalaya Delta, and Fourchon Beach are important as wintering sites for piping plovers in Louisiana. Ideal wintering habitat for piping plovers on the Gulf Coast would contain large sand flats or sandy mud flats adjacent to a tidal pass or tidal inlets.

The piping plover's diet consists mainly of invertebrates. These birds forage predominantly in intertidal areas having a substrate composed primarily of sand.

4.3.5.2.5.4. Mammals

Aquatic mammals (e.g., seals and whales) do occur in the coastal waters of Louisiana. Only the Atlantic bottle-nosed dolphin (Tursiops truncatus) occurs in the larger shallow open water bays adjacent to the Gulf where they eat fish. All others marine mammals can be regarded as rare or accidental users of Louisiana inshore waters because their habits are oceanic. Whales are similarly characterized.

Louisiana black bear (T)-

Cause for decline has been attributed to past and potential habitat losses, the vulnerability to human persecution, and illegal killing.

Present populations exist in the Atchafalaya and Tensas River basins of Louisiana and southwestern Mississippi. Currently, a small population of Louisiana black bear exists in southern St. Mary and Iberia Parishes, Louisiana (Hammond 1989, Pace 1992).

Louisiana black bears utilize a variety of mostly

terrestrial habitats including forest, and agricultural areas, occasionally marsh and require large areas of relatively undisturbed bottomland hardwood habitat. Activity centers around foraging, search for cover, and breeding.

They exhibit a seasonal shift from succulent, herbaceous growth in the spring, to soft mast in the summer, to hard mast in the fall. Animal foods supplement plant foods during all seasons.

4.3.6. Significant Socioeconomic Attributes

Overview

In the permit process administered by the Corps of Engineers, consideration of the effects of HM efforts upon significant socioeconomic attributes occurs during the public interest review phase of the permit evaluation process.

The regulations that are the basis of the permit evaluation process do not oblige or encourage us to consider benefit/cost ratios. Neither are we obliged nor encouraged to develop detailed profiles of socioeconomic attributes as is the requirement for Corps civil works projects.

NEPA, however, does require the Corps to consider socioeconomic attributes in its EIS's. Accordingly, and only within the context of this programmatic EIS, NOD presents the following profiles of socioeconomic attributes to demonstrate the relationship between these attributes and HM efforts.

Summary

Man is a significant attribute. His relationship with marshes and their management can be gauged socioeconomically.

Decisions to hydrologically manage marsh appear to be very frequently socioeconomically driven. Socioeconomic decisions are expected to continue to influence decisions to manage Louisiana's coastal marshes. The LaDNR-Coastal Management Division also accounts for socioeconomics in their permit process (Broussard et al. 1989).

Efforts to initiate a HM plan involving a portion of Louisiana's coastal marshes may have a much wider range of potentially significant individual and interrelated social and economic effects than perhaps routinely presumed by members of the public at large.

The following was summarized from the Socioeconomic Appendix (Appendix H).

4.3.6.1. Hazardous, Toxic and Radioactive Wastes

The potential for any such substances to be present at any given site is acknowledged. Permit evaluations included considerations of pollutants. However, it is beyond the scope of this PHMEIS to conduct initial HTRW site assessments for each and every candidate HM project. At a minimum, an initial site assessment has been or will be performed by the Federal agency that sponsors a CWPPRA HR or MM project included on priority lists and subjected to advanced design and analysis.

4.3.6.2. Fish and Wildlife Resources

4.3.6.2.1. Commercial

4.3.6.2.1.1. Overview

For the period 1984 to 1993, Louisiana, on average, has accounted for 19 % of the United States' total fisheries landings (by weight). Louisiana's 1993 landings were valued at $ 261 million, second only to Alaska's $1.4 billion.

Over that same time period, total yearly landing weights indicated a declining trend. Reductions of marsh quality, marsh quantity and over fishing were noted as reasons landings may have declined.

Growing competition from foreign markets, regulatory requirements (in the form of turtle excluder devices and restrictions on the use of gill nets), aquaculture and the effects of recreational fishing have all adversely impacted the commercial fishing industry. Nonetheless, commercial fishing endeavors still support a wide range of related businesses that are estimated to employ about 90,000 individuals with an economic impact of $ 1.5 billion. But, a decline may be in the offing (Minello 1994, EPA Structural Marsh Management Workshop).

During the 1972 to 1992 time frame, the number of alligators harvested increased from 1,350 to more than 24,000. Correspondingly, the value has increased from about $75,000 to $13.5 million.

Conversely, the harvest and value of other furbearers has declined. During 1945-1946, over eight million muskrat pelts were taken. In the 1983-1984 season only slightly more than 12,000 pelts were taken. Several economic and social factors are identified as potentially responsible for

this decline. An interesting side effect is the concern expressed by many landowners that overpopulation of some furbearers is contributing to marsh losses.

4.3.6.2.1.2. Basis

As previously indicated, one of the major stated purposes of HM projects previously permitted by the Corps has been to maintain fish and wildlife resources important for both commercial and recreational purposes. Extensive research by biologists, and more recently fish and wildlife economists, has explained the relationship between the productivity of the Louisiana coastal environment and trends in the level of commercial harvests in the State. As shown in Table 4.-1, Louisiana, on average, accounted for 19 percent of the U.S. total (including Alaska and Hawaii) of commercial fishery landings for the period from 1984 to 1993.

The vast majority of total pounds of fish and shellfish landed in Louisiana has been menhaden, largely exported and used for industrial purposes. Much of the total value of fishery landings has been from the harvest of shrimp, oysters, blue crab, crawfish, tuna, red snapper, sea trout, black and red drum, sea catfish, flounder, mullet, and a wide variety of other finfish. Usually more than half of the total value to the commercial fisher comes from shrimp landings. Menhaden ranks second in dollar value, followed by blue crab, oysters, tuna, and crawfish. In 1993, the total value of commercial landings in Louisiana, as reported by NMFS, was $261.8 million. These figures do not include a substantial level of domestic fishery landings which may go unreported by the fishing industry due to the voluntary procedures used in data collection and the independent traditions of the commercial fishing community. The total value of landings in Louisiana ranked second only to Alaska, with commercial landings valued at $1.4 billion. About 70 percent of the Nation's domestic shrimp landings have been at Gulf ports (NMFS, 1994).

Louisiana's coastal marshes make up approximately 64 percent of the total along the Gulf of Mexico (U.S. portion) and nearly 40 percent of the costal marshes in the contiguous 48 States. In Louisiana this habitat has been declining at an alarming rate (25-35 square miles per year). This habitat loss, combined with overfishing, contributes to the apparent fishery decline indicated in Table 3.1.1.1.

However, statewide trawl and seine data from Louisiana Department of Wildlife and Fisheries from 1976-1994 indicate no significant trends in catch per unit effort for brown and white shrimp, red drum and menhaden and other estuarine/marine fish (Condrey et al, 1995). In addition,

the number of commercial fishing licenses issued in the state has declined from 95,174 in 1990 to 72,425 in 1994 (La. Dept. of Wildlife and Fisheries Database - Step E, pg 60). Thus, these facts do not lead to the conclusion that there are an increasing number of commercial fishermen competing for a decreasing number of fish. However, there is increasing competition between recreational and commercial fishers.

In addition to the problems associated with declining production, overfishing, and the adverse impacts of deteriorating estuaries, the Gulf commercial fishing industry has experienced the effects of growing competition from foreign markets. For example, the amount of fresh and frozen shrimp imported from 1984 to 1993 has increased from 328,916 thousand pounds valued at about $1.2 billion in 1984 to 592,808 thousand pounds valued at about $2.2 billion in 1993. Foreign competitors include developing countries where labor costs tend to be lower and where capital investments may be substantially supported by the governments.

Aquaculture in the United States and foreign countries is another significant factor in the market for shrimp, oysters, crawfish, and other fishery products. As methods of production have become more efficient and competitive, the potential for aquaculture capturing a greater share of the seafood market has grown. The development of aquaculture has changed the structure of the industry, as well as prices and levels of production, and is likely to remain competitive with more traditional methods of harvest.

Other important issues characterize the setting for the commercial fishing industry in coastal Louisiana. One of these issues has been the Federal requirement that shrimpers use turtle exclusion devices (TED's) which commercial fishermen believe to significantly reduce their catch and therefore net return. The amount of bycatch, or the amount of fish shrimpers have been catching and disposing of while harvesting the more valuable shrimp harvest, has been another controversial issue in recent years. The possibility of requiring a bycatch excluder device is being seriously considered. The increasing popularity of recreational fishing has had a negative impact on commercial fishing and created substantial controversy. This has led to bans on commercial harvest of popular fish (for example, redfish) and severe restrictions on the use of gill nets in the state of Louisiana. Consideration is being given to]limited entry, moratoriums, license limitations, and individual quotas.

TABLE 4.-1.

U.S. AND LOUISIANA COMMERCIAL LANDINGS
1984-1993 (thousands of pounds)

YEAR	LOUISIANA	U.S. TOTAL	% OF U.S.
1984	1,931,027	6,437,783	30
1985	1,704,498	6,257,642	27
1986	1,699,321	6,030,634	28
1987	1,803,944	6,895,726	26
1988	1,356466	7,192,553	19
1989	1,227,941	8,463,080	15
/1990	1,061,228	9,403,571	11
1991	1,192,539	9,484,194	13
1992	1,013,575	9,637,303	11
1993	1,292,893	10,466,895	12
TOTAL	14,283,432	80,269,381	19

Source of Table 4.-1, U.S. Department of Commerce, National Marine Fisheries Service, "Fisheries of the United States" annual volumes 1984-1993.

Although much less important in terms of the economic significance, furbearers and alligators are also commercially harvested for pelts, hides and meats. From 1972 to 1992 the annual harvest of alligator skins increased from 1,350 to an estimated 24,000. The value of an average skin increased from about $55 in 1972 to more than $400 in 1991. The total commercial value of the alligator harvest has increased from about $75.5 thousand in 1972 to more than $13.5 million in 1992 (LDWF, unpublished).

While the harvest and value of alligators have increased, the harvest of furbearers has declined. During the 1945-46 season, for example, an estimated 8.3 million muskrat pelts were taken in Louisiana. During the 1993/4 season, only 12,000 muskrat were harvested. Over 1.2 million nutria were taken in the 1984-85 season, but the harvest declined to 216,000 in 1993-94.

As reported by the LDWF, a variety of factors has caused the sharp decline in demand for fur. Among them have been a doubling of worldwide production of ranch mink, several mild winters, market saturation, shifts to alternative products, general economic conditions, and other factors such as the animal rights movement. The decline in demand for furbearers has become an increasing concern, not only to the fur industry, but to landowners who have experienced adverse effect from the overpopulation of muskrat and nutria. The abundance of nutria caused significant damage to rice and sugarcane crops during the 1950's and 1960's. Recently, the overpopulation of muskrat and nutria has been identified as an additional cause of damage to marsh degradation and subsequent wetland loss (Cochran, 1991).

4.3.6.2.2. Recreational

4.3.6.2.2.1. Overview

A steadily increasing number of anglers seek bass in the fresher marsh types. Saltwater anglers seek species such as speckled trout and redfish. A 1984 study showed that about 180,000 licensed saltwater anglers annually spend $181 million and have nearly one billion dollars invested in boats, gear, camps, and other equipment. A later study estimated the annual economic impact to approach $900,000,000 for 1984-1985. Recently, the economics of recreational fishing have been contrasted with the economic impact of commercial fishing.

Waterfowl hunting is a very popular pursuit. Annually, it has an economic value of $10 million to the state.

More than 3,000,000 user days are expended each year recreationally fishing and hunting. Eco-tourism can account for more user days.

4.3.6.2.2.1. Basis

Louisiana has been referred to as the "Sportsman's Paradise" due to the unusual productivity of fish and wildlife resources. Freshwater fish species sought after by anglers include largemouth bass, crappie, blue catfish, channel catfish, bluegill and redear sunfish. A large and steadily growing number of anglers fish for largemouth bass in the low salinity marshes. Inshore and near-shore saltwater anglers' preferred species include spotted seatrout, red drum, southern flounder, black drum, sheepshead, Atlantic croaker, and sand seatrout. Crabs, shrimp, and crawfish are also a significant part of the recreational fishery.

Waterfowl hunting is a very popular activity in the coastal wetlands, although reduced bag limits and below average fall flights of popular duck species in recent years have somewhat depressed participation, possibly temporarily, in the sport. Goose hunting is a very popular sport, especially in the western part of the coast. Big and small game animal species such as white-tailed deer, and swamp rabbits are pursued as well, but to a much lesser degree.

Several thousand marsh camps, serving as seasonal or weekend bases of operation, are used by many local and out-of-state recreationalists as a starting point for various outdoor activities. Many of these camps, which are only accessible by boat, serve as clubhouses for the coastal area's numerous fishing and hunting clubs. Other camps are privately owned and used almost exclusively for family oriented recreation.

The primary users of the recreational resources of the study area are residents of southeastern Louisiana. Current estimates indicate that several million user-days of recreational activity occur in the coastal parishes annually. A study completed in 1984 for the Louisiana State University Center for Wetland Resources (Bertrand, 1984) estimates the 180,000 licensed saltwater sports fishermen in the State annually spend $181 million on fishing and have nearly a billion dollars invested in boats, gear, camps, and other equipment. The study estimates that total annual economic impact of fishing-related expenditures at over half a billion dollars. A later analysis, produced by the Sport Fishing Institute, put the total economic impact at nearly $900 million for the year 1985 (Sport Fishing Institute, 1988). In recent years, the economic importance of this recreation group has come to play in the increasing competition between commercial and recreational fishermen, as previously mentioned.

Louisiana is located at the southern end of the Mississippi Flyway, a major waterfowl migratory route. Nearly 70 percent of the ducks and geese that use the flyway overwinter in Louisiana's marshes. The economic value of the hunting provided by the flyway exceeds $10 million annually. Waterfowl hunting, when combined with recreational fishing supported by Louisiana wetlands exceeds 3 million annual user days.

4.3.6.3. Flood Control (Includes Health and Safety

4.3.6.3.1. Overview

Historically, southern Louisiana has been subjected to periodically high river stages, storms and hurricanes. A social and economic initiative to provide inhabited areas

protection from such events resulted in the creation of levee systems and the implementation of flood control projects. The consequence of those projects is reduced freshwater and sediment inputs to the Louisiana's coastal wetlands. Combined with the hydrologic effects of channels constructed for navigation and petroleum extraction, Louisiana's coastal wetlands are changing quantitatively and qualitatively as a result. Reduction in wetlands is believed by some to translate directly into reduced protection from storm-induced tidal surges.

4.3.6.3.2. Basis

Historically the Louisiana coastal region has been subject to periodic high river stages, storms, and hurricanes requiring levee systems to minimize flood damage. Unusually high river stages along the Mississippi River and its tributaries in 1927 led to construction of an extensive network of Federal flood control projects from Cairo, Illinois to the Gulf of Mexico during the 1930's. Other structures have been established to stabilize river conditions which would otherwise result in an eventual change in the course of the river and send most of its flow down the Atchafalaya. These flood control levees on the Mississippi reduce the flow of fresh water and sediment into wetlands and the coastal marshes. This problem is compounded in many locales by artificial channels dredged for navigation and oil and gas development. They provide conduits for seawater to penetrate far inland, and to drain rainfall rapidly seaward. These conditions, along with other structural activities for economic development, and the cycles of drainage, natural and otherwise, have contributed to increasing rates of coastal erosion and deterioration of the marshes.

A single flooding event in coastal Louisiana could be caused by any combination of three factors: local rainfall, high river stages, or tidal flooding including hurricane surges. There is a widespread view among the general public and many professionals that coastal wetlands provide protection from storm surge and thereby lower stage increases experienced in communities inland from the coast. This seems logical based on gauge readings taken during hurricanes which in general show decreasing peak stages the farther distance from the gulf the gauges are located. The degree to which coastal wetlands can ameliorate tidal surge is probably dependent on the extent and configuration of the wetlands and the path and strength of particular storms.

4.3.6.4. Land Use and Land Loss

More than 900,000 acres of wetlands were lost between 1932

and 1990. An additional 768,000 acres are estimated to be lost by 2040 if no action is taken by property owners or the public.

Traditionally, water bottoms have been considered public property, along with the subsurface mineral rights. As of Between 1932 and 1993, an estimated 900,000 acres of wetlands converted to open water. One issue that has significant economic implications is the retention of mineral rights by the landowner as marsh converts to open water.

4.3.6.5. Mineral/Petroleum Production

Mineral/petroleum extraction has played a significant role in the economics of the state and the nation for several decades. Direct and indirect losses of coastal marshes in Louisiana occurred as result. Mineral/petroleum extractions are expected to continue. The pace of that endeavor is likely to increase.

Many previously permitted management plans included design contingencies to accommodate the reality that mineral extraction activities are likely to continue into the foreseeable future. The management implication is that such provisions should be retained and updated as access and extraction technologies change and management insights are also updated.

4.3.6.6. Displacement of Farms

The displacement of farms is an issue which may be significant in evaluating HM projects because continued marsh loss, in some areas, could impact farms further inland. As subsidence, sea level rise, and land loss continues, salinity levels are likely to increase in areas further inland. These conditions could leave farms closest to the shore more exposed to the effects of storm damage and the effects of salinity. Increases in salinity in lakes and bays adjacent to crops like rice which have depended on the abundance of freshwater in these lakes and bays for production could eventually require costly adjustments in their production methods or relocation.

Rice cultivation and crawfish are the agricultural activities more likely to be immediately affected. Rice is a crop intolerant of salt. Therefore, salt water that intrudes into surface waters used for irrigating rice crops quickly those water unsuitable, forcing the grower to rely upon alternative water supplies.

The management implication is that efforts to control marsh losses may also have temporal and spatial implications to rice farming. Whether the management projects are accidentally or intentionally placed in a pattern that prevents or retards salt water intrusion makes no difference, although strategic citings are certainly possible.

The NRCS was invited to prepare a narrative on the relationship between management of coastal Louisiana marshes and prime and unique farmlands. That narrative is presented as Appendix M.

4.3.6.7. Other Business and Industries

The fishery and hunting resources support a wide range of related businesses such a processors and canners, shippers, wholesale and retail operations, restaurants, boats building and repair yards, net and other gear builders, icehouses, and commercial marinas. According to a recent study, the commercial fishing industry in Louisiana creates 90,000 jobs and has an economic impact of $1.5 billion (Keithly, 1991).

The management implication is that factions of the economy are indirectly linked to the status of Louisiana's coastal marshes. Management efforts that either slowed, stopped or reversed marsh loss could have different effects on those economic interests.

4.3.6.8. Property Value and Ownership

Camps serve as bases of operation for commercial and recreational pursuits related to the marsh. Many are accessible only by boat. Many are clubhouses, others are privately owned. Several thousand such camps are believed to exist throughout Louisiana's coastal marshes.

4.3.6.8.1. Landowners and Limiting Public Access

There appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

We perceive the issue to be that landowners feel they are unilaterally exposed to the risks and costs of vandalism and liability claims if they are forced to provide uncontrolled public access to their property or are precluded from limiting access. Littering is also an apparent concern.

When it comes to the harvest of marsh dependent resources, we perceive the issue to be whether marsh-dependent resources (e.g., fur, fish, alligators, waterfowl) are

public resources or wholly proprietary resources. The related issue is public access.

If marsh-dependent resources are proprietary, as is apparently assumed by many land owners, then the landowner, they argue, can deny access to his/her property to harvest on the basis of their being no public resource involved.

If there are public resources, then the landowner apparently feels he/she is exposed to added vandalism, trespass and liability claims if the public is allowed uncontrolled access to his/her property, the landowner is precluded from controlling access, or members of the public are enticed to trespass by the enhanced resources associated with the managed area.

4.3.6.8.2. Protecting Values Associated With Marsh Ownership

There are apparently two components to this concern: 1) preventing the loss of mineral rights/royalties; and, 2) capturing the economic values of harvestable marsh-dependent resources.

Landowners desire to protect property values associated with their marshes. First, they want to prevent the loss of mineral rights/royalties. Traditionally, the bottoms of lakes and bays are considered public property. The owners of areas which had previously been marsh have identified the need to make certain that their mineral rights have not been lost along with the marsh. When the eroded marsh becomes an extension of already state-owned water bottoms, the state is considered to be the new owner of the mineral rights on these newly formed water bottoms. Slowing or stopping erosion precludes any further loss of mineral rights to the state. This is often a basic, but unstipulated, motivation for landowners to elect to undertake HM of marshes.

Management that slows or stops marsh erosion benefits the landowners and furthers the mission of the Louisiana Departments of Natural Resources and Wildlife and Fisheries. But such restoration is counterproductive to state revenue generating needs and creates the apparent paradox that the interests of some state agencies conflict with other state agencies. [Note: The missions of several Federal agencies may also seem paradoxically counterproductive (Appendixes K - P)].

Regarding the monetary value of harvestable resources, the basic issue is that this represents an interest landowners wish to wholly retain but is typically a relatively minor source of potential or actual income to most landowners. To

a smaller number of landowners, capturing the economic values of harvestable marsh-dependent resources is the only source of income and is, therefore, of paramount importance. Either landowner group must contend with the previously mentioned concerns of unwanted/uncontrolled access by the public, and vandalism and liability.

Some landowners do not want the Federal and/or state governments restoring their marsh with public funds because they fear that they will lose the right to reclaim their land out to the 1921 line and thus lose mineral rights. A 1995 amendment to the Louisiana state constitution should solve this problem. The amendment and recent enabling legislation allows the state to bargain with landowners over the mineral rights.

4.3.6.8.3. From the Viewpoint of Members of the General Public

As was the case with the landowners perspectives, there appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

Regarding vandalism and liability, the issue appears to be that public harvesters/users feel they are improperly perceived by landowners/leaseholders as a group that is generally irresponsible. They believe this is a spurious argument for controlling access.

Regarding the harvest of marsh dependent resources, as we appreciate this issue, it has three parts: 1) public resources do not become private property simply by moving into privately owned marshes; 2) public resources, even when resident on private land, should be accessible by the public; and, 3) interfering with the free movement of fisheries organisms between privately owned, controlled access areas and publicly accessible areas adversely effects the culture, life style and economic fortunes of many people.

Access to the resource is the principal component, but ownership of the resource is also being questioned. Both are questions of law, that need not and should not be resolved by this agency. Landowners feel exposed to liability and vandalism if they allow unlimited public access to their land. The general public feels that they are improperly perceived by landowners as irresponsible and believe that this is a spurious argument for controlling access. Both access and ownership are questions of the law and will not be resolved by the Corps of Engineers via the permit process.

The tension between landowners and the general public over ownership of fish and wildlife resources and public access will continue and possibly even intensify as competition for resources dependent on a vanishing landscape feature intensifies.

4.3.6.9. Public Facilities and Services

4.3.6.9.1. General

Public facilities and services which influence or might be influenced by a demand for managing marshes are related to Federal and state agencies that have interest in: 1) promoting/managing fish and wildlife resources; 2) installing/maintaining flood control features; 3) hurricane evacuation and other emergency programs and facilities; 4) maintenance of existing navigation channels; 5) public and private environmental projects; 6) mitigation banks; 7) maintaining/operating existing infrastructure (e.g., roads, bridges, marinas); and, 8) state and Federal management/education holdings.

4.3.6.9.2. National and State Wildlife Refuges, Wildlife Management Areas, and Parks

There are several wildlife refuges and management areas within the Louisiana coastal marshes. Their locations have been plotted on the Plates. The management of most of those refuges is focused on providing high quality life requisite resources for overwintering waterfowl. The remaining refuges provide habitat for other species of migratory or resident bird species, some of which may be endangered threatened or rare, and/or migratory marine organisms.

The state wildlife management areas provide a high quality hunting, fishing, and/or trapping public lands opportunity/alternative to members of the general public.

Subordinate activities, such as recreational waterfowl hunting and/or fishing, is generally permitted on many of those facilities. Such activities typically occur on a limited basis and on a more highly regulated basis than generally is the case elsewhere.

4.3.6.10. Employment and Labor Force

Construction workers, environmental consultants, researchers, private and government scientists, regulators, land managers, contract trappers/fishers are examples of some of the professions directly linked to the management of Louisiana's coastal marshes. With so many divergent interests, the long-range economic effects are not easily or

precisely characterized. For some, operation of the managed areas is their only employment and principal source of income. For others, many of which may be retired, their participation with management may be an effort to supplement their incomes. However, the ultimate economic effect of any project is related to what degree a project or projects succeed.

The implication is that the design, implementation, operation and maintenance of management efforts involve a wide variety of professionals.

4.3.6.11. Income

The 1993 per capita personal income of the primary ten coastal parishes was about $16,780 (April, 1995 "Survey of Current Business" U.S. Department of Commerce). If the highly urbanized Jefferson Parish is excluded, the 1993 per capita personal income of the nine remaining parishes is $14,700, significantly below the $16,660 figure reported for the entire State. The lower incomes of the coastal parishes could be partially due to the lingering effects of the depressed oil economy; however, other factors may be the trend toward more automated methods of agricultural and fishery production, and the desire of residents to remain in their unique cultural environment despite a downturn in the national economy.

Another source of income is leases. Oil and gas royalties represent a potentially substantial source of income. Fur trapping, hunting, fishing, and cattle grazing leases are other sources of income to landowners.

The management implication is that many sources of income are derived from or related to marshes. Management, or the lack of it, could have substantial effects.

4.3.6.12. Displacement of People

According to a 1993, 20-parish study prepared for the Louisiana Coastal Wetlands Restoration Plan, approximately 23,000 people living in communities along the coast might require relocation by 2040 if no action was taken to reduce land loss. Many more people might be displaced as a result of the disruption of economic activities.

See also 4.3.6.8. Property Value and Ownership

4.3.6.13. Tax and Fees (Licenses)

Management of coastal marshes contributes to the tax base of local communities, the state, and the Gulf coast region

through property, sales, and income taxes. On the other hand, state-owned waterbottoms with producing oil and gas facilities contribute to the state budget. If the taxable resource is dependent on a declining support system (the marsh), then revenues will decrease as the marsh disappears.

The management implication is that successful management efforts have potentially positive effects on existing and future tax bases and revenues. The converse may also be true in the longer term.

4.3.6.14. Community and Regional Growth

Management of Louisiana's coastal marshes would seem to contribute to at least sustaining community and regional growth at something approaching current levels in the short-term. The long-term management implication is less clear. However, it would seem to hinge on management success outweighing failures or short falls if current linkages between community and regional growth and management are to be sustained. An unknown is how the relationship between landowners and their interests will interact with the interests of competing user groups.

See also 4.3.6.16. Community Cohesion

4.3.6.15. Health and Safety

Management of Louisiana's coastal marshes may contribute to the health and safety of communities and the region. This benefit arises from coastal marshes serving to reduce flooding. The success of the projects at slowing, stopping or reversing marsh losses (actual marsh gain) would be correlated with the magnitude of the benefits.

The implication is that managed marshes in an eroding marsh system contribute to flood reduction.

See also 4.3.6.3. Flood Control

4.3.6.16. Community Cohesion

Community cohesion is the force which creates social bonds within a community. It may be characterized through many forms, including religion, ethnic background, education, income, recreation, or other factors considered of mutual economic or social benefit. The past availability of an abundant source of fish, shellfish, and wildlife, for both commercial and recreational purposes, has been important to a broad spectrum of groups throughout the coastal area. The cooperative efforts of the citizens of local communities and regions during flood emergencies and hurricane evacuations

have also contributed to the overall community cohesion of groups within the area. On the other hand, the differing interests and needs of various elements of the community can cause friction and reduce overall community cohesion. For instance, the recent controversy between recreational and commercial fishermen over a diminishing resource has been a source of conflict in many communities.

The rich fish and wildlife resources of coastal Louisiana are a unifying feature in that commercial and recreational participants have expressed interests in the health and well being of the marshes and its associated and dependent resources. However, that same resource has been a source of friction. Those two interest groups are competitive users of the exact same resources that are dependent upon a diminishing resource base.

The management implication is that the forces that bind a community together and the forces that separate community elements are both at work at the same time. Resolution of the issues may not be easily achieved, if at all.

4.3.6.17. Aesthetics

Louisiana's coastal marshes, as well as the bayous, bays and barrier islands, are unique landscapes that reflect, as well as support, the lifestyles and traditions of different groups along the coast.

The vast expanse of wetlands, only sparsely populated by humans, densely populated by plants and wildlife, the winding bends of the bayous, and extensive network of lakes and bays which lead to the sounds, the barrier islands and Gulf of Mexico produce a harmonious whole pleasing to many. The presence of oil and gas operations is characterized by some as adversely effecting the aesthetics of the marsh. The aesthetic value of managed versus unmanaged marshes lies in the eye of the beholder.

4.3.6.18. Noise

Because the coastal wetlands are largely unpopulated by humans, threats to human health on a large scale appear unlikely. However, noises associated with construction, maintenance and operation of managed areas may pose a localized, short-term impact to operators as well as some animal species. Some noises associated with managed areas, (e.g., gun blasts while hunting) may pose a threat to the immediate health of the participant.

Construction and maintenance induced noise can also have transient effects on animal species. Typically, it disrupts

some aspect of their breeding biology.

The management implication to humans is to be responsible in performing installation, operation, maintenance and any other functions only when wearing protective hearing devices. The management implications for wildlife is to schedule or site potentially disruptive activities at times or places where the potential for disturbance is minimized or avoided as much as reasonably possible.

4.3.6.19. Environmental Justice

Executive Order 12898 requires all Federal agencies to seek to achieve environmental justice by "....identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects its programs, policies, and activities on minority populations and low-income populations".

Managing Louisiana's coastal marshes creates a paradox. Landowners who attempt to protect their marshlands and dependent interests with existing HM technology unavoidably affect, adversely in the short-term, certain groups (e.g., fishermen) or individuals.

4.3.6.20. Existing Approximations of Structural Management Feasibility

Plate 8 from Cahoon and Groat (1990) is entitled, "Marsh Management Feasibility." It depicts where in Louisiana's coastal marshes the feasibility of structural MM (AM, PMM, some forms of HR) **may be** constrained individually or additively by marsh soil types (with potentially constraining physical characteristics), a relative sea level rise rate $\geq$ 1 in/yr. (2.5 cm/yr) and an index representative of high land loss rates.

In the marshes of Chenier Plain Basins (Basins 8 and 9) and the marshes that comprise the western rim Delta Basin 7, management feasibility was generally perceived to be limited only in the north and central portions of the Calcasieu-Sabine basin because of habitat stability (land loss). A brackish to saline marsh soil type is a potentially constraining factor throughout the entire Delta Region marshes. Relative sea level rise rates were depicted as an additional constraint encompassing the central and eastern Terrebonne Basin (Basin 5). Site-specific marsh losses were constraints in much more isolated locations in the northern (generally fresher) tier of marshes between the Mississippi and Atchafalaya Rivers.

4.3.7. Significant Cultural Attributes

Over 2,400 archaeological and historical sites exist within the hydrologic basins encompassed by this F-PHMEIS. Collectively, these sites span the human occupation sequence of the state and represent Louisiana's long cultural heritage.

The prehistoric sites are predominantly Indian shell middens situated along the natural levees of rivers and bayous and surrounding shorelines of the coastal lakes. Archaeological evidence indicates that these prehistoric Indians gathered both freshwater and brackish water shellfish. These sites were habitation sites as well as camp sites for shellfish processing.

Historic sites date to colonial times and are also located on natural levees. Domestic buildings or their ruins, boat landings, hunting and fishing camps, farm and plantation buildings, shipwrecks, and military fortifications are examples of the existing resources. Many of the archaeological sites and historic properties have been determined eligible to be or are listed on the National Register of Historic Places.

The Cultural Appendix (Appendix J) includes a description of the procedures used to identify cultural resources associated with project sites and activities and actions taken to reduce/avoid adverse impacts to those resources or any discovered during construction of authorized projects. Those procedures were used during the processing of previously permitted projects.

4.4. **Marsh (Land) Loss**

4.4.1. Overview

Louisiana's coastal marshes are the result of an ever present, dynamic interaction between factors that result in marsh creation opposed by factors that lead to marsh losses. Some factors are expressed on short geologic time frames (e.g., decades, centuries) or regional scales (e.g., physiographic regions). In contrast, others are expressed on short time frames (e.g., days, weeks, months) or relatively small geographic scales (e.g., tens, hundreds, thousands of acres). Therefore, the effects of shifts in some factors may be detected more readily than others.

Seldom was or is there truly a period of prolonged absolute balance anywhere or at anytime in Louisiana's coastal marshes. Since about the early 1800's, man has been accidentally as well as intentionally influential in

modifying some of those factors. Channelizing and leveeing the Mississippi and Atchafalaya Rivers, and the excavation of waterways for navigation and oil and gas exploration and recovery operations are examples of man's actions that have impacted several influential factors.

The consequence of man's actions in Louisiana's coastal zone has been to accentuate the factors that result in marsh losses (Gagliano et al. 1981). Man's actions contributed to stressing or exceeding the ability of marsh plants to contend with the induced differences. Thus, especially over the last 40 years, marshes have converted to open water at various rates and the probability of that trend continuing at an accelerated rate is seemingly inevitable (Gagliano et al. 1981) if corrective actions are not taken. Gagliano's projected loss rates have not been substantiated by subsequent studies (Britsch and Kemp 1990; Dunbar, Britsch and Kemp 1990, 1992).

4.4.2. Historic Marsh Loss Rates/Deterioration

The terms marsh loss and marsh deterioration are often used interchangeably to describe shifts in marsh plant species assemblages to more salt tolerant marsh types that are less attractive to some marsh-dependant species. However, some Louisiana coastal marshes have changed from one type to another and back again for reasons totally unrelated to erosion. Therefore, the term marsh deterioration would apply to a marsh that is undergoing a natural, irreversible change towards more salt-tolerant plant species, but that same marsh may not yet exhibit signs of erosion.

4.4.2.1. Delta Basins

4.4.2.1.1. Basin 1 - Pontchartrain

On an annualized basis since 1932, about 10 % (90,000+ acres) of Basin 1's 1932 land area has converted to open water (Appendix D). After doubling during the 1958-1974 time period, the 1983-1990 annualized percentage and acreage loss rates are approaching the ambient rates observed during the 1932-1958 time frame, or slightly less than about 2.0 square miles per year. Within the basin, current losses are generally greater in the portion of the basin south and east of the eastern rim of Lake Pontchartrain.

4.4.2.1.2. Basin 2 - Breton

On an annualized basis, about 16 % (37,000+ acres) of Basin 2's 1932 land area has converted to open water since 1932 (Appendix D). The annualized loss rate as a percentage and as acres lost nearly tripled by about 1960 and has again

accelerated since the mid-1970's, and equates to current loss rate of slightly less than 1.5 square miles per year. Within the basin, current losses have generally been greater in the central and southeastern two-thirds of the basin. Shoreline erosion, altered hydrology and subsidence have been identified as contributing to the historic and current losses. The bulk of the marsh losses in this basin occurred predominantly during the 1958-1974 time frame.

4.4.2.1.3. Basin 3 - Mississippi River Delta

The active Mississippi Delta (Basin 3) was not mentioned because there have been no permits granted for MM in that basin. Furthermore, the only proposed HR project is "....purely conceptual."

4.4.2.1.4. Basin 4 - Barataria

On an annualized basis since 1932, about 16 % (190,000+ acres) of Basin 4's 1932 land area has converted to open water (Appendix D). After tripling during the 1958-1974 time period, the 1983-1990 annualized percentage and acreage loss rates have increased slightly once again. Within the basin, loss rates span an order of magnitude but generally occur evermore rapidly in the central and southeastern two-thirds of the basin. The annualized loss rate of 7.37 sq. mi. per year for the 1983-1990 time frame is the highest, most recently documented loss rate in coastal Louisiana.

4.4.2.1.5. Basin 5 - Terrebonne

On an annualized basis since 1932, about 20 % (200,000+ acres) of Basin 5's 1932 land mass has converted to open water (Appendix D). After exhibiting a five-fold increase during the 1958-1974 time period, the 1974-1983 annualized percentage and acreage loss rates began a slight decline that is still apparent in the 1984-1990 time frame. However, the most recent loss rate is still nearly four times the land loss rate recorded during the 1932-1956 time frame. Within the basin, loss rates span an order of magnitude but the most rapid loss rates occur in the east central and southeastern one-third of the basin. Elsewhere, loss rates are fairly uniform with some localized exceptions to the general pattern.

4.4.2.1.6. Basin 6 - Atchafalaya

On an annualized basis since 1932, about 9 % (7,800+ acres) of Basin 6's 1932 land mass has converted to open water (Appendix D). After exhibiting a fractional increase during the 1958-1974 time period, the 1974-1990 annualized percentage and acreage loss rates have declined to about

half of what they were during the 1932-1958 time frame. Shoreline erosion and direct man-made losses account for nearly all the recorded losses.

Net marsh losses in this basin are probably less than have been recorded. The National Biological Service (a United States Department of the Interior agency) maintains a data base that is sensitive to marsh gains. Measurable marsh gains have been recorded in this basin. However, those gains are principally associated with the actively accreting Atchafalaya River and Wax Lake Outlet deltas and are occurring at the expense of the shallow open water of Atchafalaya Bay, not where historic marsh losses have occurred.

4.4.2.1.7. Basin 7 - Vermilion-Teche

On an annualized basis since 1932, about 9 % (50,000+ acres) of Basin 7's 1932 land area has converted to open water (Appendix D). After more than doubling during the 1958-1974 time period, the annualized loss rate has declined and today is slightly less than double the rate for the 1932-1951 period. Within the basin, loss rates can nearly be an order of magnitude different depending upon location. Some of the highest loss rates are correlated with areas of shoreline erosion.

4.4.2.1.8. Delta Basin Summary

Collectively, losses from Delta Basins 1, 2, 4, 5, and 7 amount to about 367,000+/- acres since 1932. Expressed as percentages of each basin area, losses range from nine to 20 percent. Basin 1 and 7 (10 and 9 %, respectively) exhibited half the historic loss recorded in Basin 5 (20 %). Percentage losses in Basin 2 and 4 were identical (16 %).

Erosion of the Gulf shoreline, wetlands that form the rims of large open water bodies, and exposed headlands have been a persistent problem throughout the period of record in all Delta basins. Some localized differences have been noted. Generally, shorelines exposed to long fetches of prevailing winds tend to evidence greater amounts of erosion. Visual inspection of NOD's early draft, color-coded maps of land loss in coastal Louisiana revealed that recorded internal marsh losses occurred in clusters, most often focused around manmade waterways or manmade surface landscape features (especially so in Basins 4 and 5). Additionally, most of the historic losses associated with clusters around petroleum extraction canal systems occurred within the 10-to-20 year period after the canal system was excavated. Subsequent losses in those same canal system clusters since the 1980's have been proportionately very little.

4.4.2.2. Chenier Plain Basins

4.4.2.2.1. Basin 8 - Mermentau

On an annualized basis since 1932, about 19 % (115,000+ acres) of Basin 8's 1932 land mass has converted to open water (Appendix D). After exhibiting a three-fold increase during the 1958-1974 time period (which encompasses the passage of Hurricane Audrey), the 1974-1983 annualized percentage and acreage loss rates changed little. The loss rate from 1984-1990 was lower but was nearly double the rate from 1932-1954. Within the basin, the most recent loss rates span an order of magnitude but the most rapid loss rates occur along the Gulf shoreline and inland along lake rims adjacent to marshes. Localized exceptions to this general pattern do exist.

4.4.2.2.2. Basin 9 - Calcasieu-Sabine

NOD's land loss data set do not include the western-most fifth of this basin. That portion of the basin is administrated by the Galveston District, Corps of Engineers. Thus, the following discussion is correspondingly limited.

On an annualized basis since 1932, about 32 % (117,000+ acres) of Basin 9's 1932 land mass has converted to open water (Appendix D). The basin-wide marsh loss during the 1958-1974 time frame is powerfully suggestive, if not conclusive evidence, that some basin-wide change(s) had or were occurring. However, losses simultaneously occurring in both managed and unmanaged areas only complicate efforts to determine the individual or interactive effects of hurricanes in 1957 and 1961 and the deepening of the Calcasieu Ship Channel from 35 feet deep (since 1953) to 40 feet deep (from 1962-1968). After exhibiting a nearly 30-fold increase during the 1958-1974 time period, the 1974-1983 annualized percentage and acreage loss rates began a dramatic decline that by the 1984-1990 time frame was still greater than but very near the loss rate from 1932-1955. Within the basin, local loss rates differ but are within the same order of magnitude. Loss rates in the extreme southwestern and southeastern corners of the basin are particularly low.

Net marsh losses in this basin are probably less than have been recorded. The National Biological Service (a United States Department of the Interior agency) maintains a data base that is sensitive to marsh gains. Measurable marsh gains have been recorded in this basin during the 1980's and early 1990's. Those gains have come at the expense of shallow open water areas within managed as well as unmanaged areas.

4.4.2.2.3. Chenier Plain Basins Summary

Collectively, losses from the two Chenier Basins, Basins 8 (Mermentau) and 9 (Calcasieu-Sabine) amount to about 232,000+/- acres since 1932. Expressed as percentages of each basin area, losses are 19 % and 32 %, respectively.

Erosion of the Gulf shoreline in both basins and the loss of marshes that form the rims of large open water bodies, especially in basin 8, have been persistent problems throughout the period of record. However, visual inspection of NOD's color-coded maps of land loss in coastal Louisiana clearly revealed that internal marsh losses have been extensive for the period of record in both basins, especially during the 1932-1974 time frames.

In both basins, extensive losses have occurred in proximity to surface features created by man. In the Mermentau basin, losses during the 1932 to 1974 time frames visually appear to exhibit two larger-scale patterns: 1) clustered; and 2) more regularly occurring. Clustered losses were decidedly more visually apparent in and about the several petroleum extraction canal systems north of and easterly from the Grand Chenier ridge. More regularly occurring losses were visually prominent in the marshes between the Grand Chenier ridge and the Gulf of Mexico. Losses that have occurred more recently (1974-1990) are either in the shape of rectangles, especially on the very eastern end of the Grand Chenier ridge, or within the area circumscribed by other man made surface landscape features (e.g., northerly from Lake Misere and northwesterly from the northwest shore line of White Lake).

In the Calcasieu-Sabine Basin, marsh losses east of Calcasieu Lake have been most extensive within the area bounded by the GIWW on the north, LA Highway 27 on the east, the Back Ridge chenier system along the south and to the west by the eastern lake rim of Calcasieu Lake. The vast majority of the marsh losses in this area occurred during the 1932-1974 time frame. Rising and persistent salinity stress to native fresher-water marsh plants was the apparent proximate reason for those losses.

Many areas of marsh loss west of Calcasieu Lake, especially in the eastern half of the vast marsh area between Sabine and Calcasieu Lakes, are notable for their geometric patterns of repeated right angles and long straight margins. Such areas coincide remarkably well with areas formerly impounded and managed specifically to open the marsh up to make it more attractive to waterfowl. Former agricultural efforts may also account for some of the recorded marsh loss. Outside managed areas, the consequent effects of

rising and persistent salinity stress to native fresher-water marsh plants is the apparent proximate reason for recorded marsh losses.

4.4.2.2.4. Louisiana Coastal Zone Summary

Losses on a percentage basis vary considerably. Basins within the same region exhibit obvious differences. The reason for the losses differ between basins, sometimes more so than do the reasons between regions. These trends suggest that site specific reasons for land (marsh) loss can be determined for many but not all locations and that surface land loss rates in general have slowed over the last 10 to 15 years. Land (marsh) losses are expected to continue.

4.5. **The Cooperating Agencies and HM**

4.5.1. Non-COE Agencies

Two Federal resource agencies {i.e., U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS)} are involved principally as commentors on more formalized management proposals. The FWS manages marshes within its refuge system and has prepared a draft policy on MM but has not released it to the public.

The State of Louisiana has promulgated some general policy level initiatives (Coastal Restoration Technical Committee 1988, Edwards, et al. 1995), been involved with some individual management plans to include preparation of monitoring reports (Clark 1989 a,b); attempted to address some site-specific problems (Wetland Conservation and Restoration Task Force, 1990), have up-dated their coastal restoration strategy (Gagliano 1994), and have had a published policy concerning wetland management and HR since 1993 (Good, Clark and Soileau 1993).

The EPA has taken steps to collect information about MM (Environmental Protection Agency 1994) in support of an initiative that is intended to produce an agency policy on MM.

Accounts of what the non-COE agencies do when it comes to evaluating permits applications from the perspectives of their respective agency mandates are presented as Appendixes, as indicated.

4.5.1.1. U. S. Fish and Wildlife Service (FWS)

This agency's narrative is presented as Appendix K.

4.5.1.2. National Marine Fisheries Service (NMFS)

This agency's narrative is presented as Appendix L.

4.5.1.3. Natural Resources Conservation Service

This agency's narrative is presented as Appendix M.

4.5.1.4. Louisiana Department of Natural Resources

This agency's narrative is presented as Appendix N.

4.5.1.5. U. S. Environmental Protection Agency

This agency's Narrative is presented as Appendix O.

4.5.1.6. Corps of Engineers, New Orleans District.

This agency's narrative is presented as Appendix P.

5.0. *PRIOR AND FUTURE HM ACTIONS: EFFECTS, AND SYNTHESIS/SUMMARY*

An examination of prior HM permit actions begins this section of the F-PHMEIS (5.1.). Section 5.2. profiles the candidate CWPPRA HM projects. Section 5.3. is where the "Future With Additional HM" data set is characterized by merging the permit and CWPPRA data sets. Sections 5.4., 5.5, 5.6. and 5.7. are discussions of the "Futures Without (No Action) and Future With Additional HM" on the significant physico-chemical, biological, socioeconomic and cultural significant attributes, respectively. Section 5.8. presents a synthesis/summary and regulatory implications.

5.1. **Prior HM Permit Actions**

5.1.1. NOD's Prior Permit Actions Data Set

A "marsh management" permit data base was constructed from those files and was used to characterize chronological trends and to infer correlations relative to: 1) stipulated reason(s) for undertaking management; 2) the marsh types (but not individual acreages by type) included within each permit; and, 3) the geographic scales over which the above relationships can be detected.

NOD's Regulatory Functions Branch (NOD-RF), within the Operations Division, administers the permit programs applicable to activities and structures affiliated with HM.

NOD-RF's listing of permit actions between 1977 and 1996 (January) were transcribed and input into a QuatroPro spreadsheet program maintained by NOD for analysis. The summary statistics and figures referred to in the following narrative were generated and are maintained within that data management environment.

The data were reported by the year a permit was issued, physiogeographic region, hydrologic basin within region, acreage, whether the permitted plan was active or passive, to what degree was it implemented, by purpose for which management was to be undertaken and what marsh types were included with the projects' "footprint". An examination of these attributes provides a basis for characterizing past and future impacts.

5.1.1.1. Follow-up

Between October 1994 and March of 1995 NOD attempted to contact each and every one of the MM permittees for the purpose of confirming the status of the projects. At least

one and often multiple follow-up contacts were attempted for each initially nonresponsive inquiry. For those permittees that did not respond to our inquiry, NOD assumed that the project had been installed in part. Projects that we were able to confirm had not been initiated/installed and for which the permit had expired were not carried forward in our acreage tallies.

Appendix C is a presentation of the permit data.

5.1.1.2. Permit Landscape Patterns

Permitted areas can exhibit patterns over the landscape. When they do, the patterns may have cumulative impact implications.

5.1.1.3.. Monitoring

5.1.1.3.1. The Concept of Measuring Management Success

Until recently, marsh scientists and managers have had the luxury of commenting on the potentialities and shortfalls of someone else's proposed HM effort. Now, as prominent participants in the CWPPRA planning process, government and private managers and scientists are being held socially, financially, and scientifically accountable for their decisions to implement some and not other plans despite their inability to provide unequivocal answers to cogent questions. Thus, determining the potential for success of publicly funded management efforts has been elevated to a more prominent level of concern under CWPPRA.

Monitoring has attempted to play a role in that capacity in the past but will play a much more prominent role in the foreseeable future under CWPPRA.

Commensurate with today's emerging emphasis on combatting marsh erosion, interest now more than ever before focuses on the response of the marsh landscape to management. For example, CWPPRA provides for tracking how HM efforts effect the marsh/open water ratio, or the marsh surface elevation/water level relationship. Both measures reflect the greater emphasis on the health and dynamics of managed marshes.

The concept of successful management is becoming progressively less often infused with professional intuition (de la Cruz 1976b). It is becoming more data intensive and oriented to documenting and understanding the changes in biological processes induced by management rather than simply attempting to record the biological outcome of management efforts.

Monitoring of some physico-chemical attributes is a typical condition included in Federal and/or state permits. That will likely continue to be the case, although CWPPRA projects provide for significantly more pertinent and definitive monitoring than has typically been included as conditions to Federal or state permits.

Within a larger management context, monitoring has been and will continue to be multi-dimensional (Simmering, Woodard and Clark 1989; Cameron Creole, etc.), and in some cases is specifically inclusive of fisheries (Pittman and Piehler 1989; Paille and Schuck 1993), vegetation (Sweeney, et al. 1990; Flynn and Mendelssohn, 1991), and short-term water budgets (Day and Conner 1990) and sediment and nutrient fluxes (Boumans and Day 1990).

Monitoring within a regulatory context continues to focus on documenting the effects of management on biological resources and processes, primarily to allow for fine-tuning of projects. Neither NOD nor CWPPRA provides for monitoring the social and economic effects of projects. However, NOD's monitoring requirements address some of the mentioned above. CWPPRA's monitoring is capable of addressing many if not all of those attributes.

5.1.1.3.2. Permits and Monitoring

Some kind of monitoring was explicitly required in approximately two-thirds of the permits that NOD has issued (Tables C.1. - C.10., C.12.). The decision as to which suite of attributes was to be monitored in what way usually was project-specific.

Not all monitored attributes were measured in identical ways in all cases. However, how often any given attribute was to be monitored and how frequently monitoring reports were to be submitted and reviews undertaken have been approximately the same since the mid-1980's.

5.1.1.4. Correspondence with Stipulated Purpose

Marsh restoration and improvement of habitat for waterfowl have been cited by managers for years and more recently by permit applicants as independent or combined reasons for wanting to undertake management. The following narrative summarizes an examination of the relationship between stipulated reason(s) and permitted projects.

From the literature and our permit experience, management focusing on waterfowl habitat improvement is typically undertaken for one or more of the following reasons: 1) improving conditions is - a) aesthetically pleasing and/or

b) recreationally and/or economically rewarding (from improved habitat conditions and expanded and reliable access); and/or, 2) is ecologically necessary to forestall reductions of overwintering waterfowl populations. We are not aware of any studies or records addressing aesthetics or the recreational/economic rewards of managed marshes. However, Michot (1995 galley proof) attempted to quantify the relationship between marsh loss in coastal Louisiana and overwintering waterfowl numbers. He was unable to demonstrate any statistical or biological relationships between the numbers of overwintering waterfowl and historic marsh losses in coastal Louisiana. He proposed two explanations as a result of his efforts. Paraphrasing one explanation, absent management, declines in waterfowl numbers might have occurred. Paraphrasing his second explanation, the remaining acres of coastal marsh still exceed the life requisite requirements for food, water and shelter for the overwinter migratory waterfowl populations.

There are no photographic or other records with which to directly measure and quantify the historic relationship between marsh and waterfowl or management efforts and the response of targeted waterfowl. Surrogates often used to infer an improvement are: 1) if and when certain resources used by waterfowl are more numerous or more abundant within the managed area; and, 2) yearly waterfowl use and/or harvest figures from the managed area. However, those surrogates can be highly variable.

Ultimately, NOD concluded it would be fruitless to attempt to identify and quantify meaningful trends relative to overwintering waterfowl numbers within our permit data base.

The maps and photographic records available to NOD may or may not reveal the efficacy of permitted marsh restoration efforts in slowing, stopping or reversing marsh loss because permitted marsh restoration efforts may or may not appear on the maps or be linked with historic marsh losses. Thus, the marsh erosion stipulated by applicants as a reason they are seeking a permit: 1) could have occurred- a) but on a scale not detected by our marsh loss/erosion data collection techniques, and b) was not reported in monitoring reports; or, 2) did not in fact occur to a measurable degree, suggesting the management effort was- a) successful at forestalling anticipated losses, b) a misuse of the term in the context of changing marsh types (marsh deterioration) rather than acreage conversions, or c) misrepresentation/misunderstanding of the relative emphasis on the stated purpose(s) for the management action. Therefore, NOD acknowledges that comparing marsh restoration as a stipulated purpose and project location with time sequence photographs of Louisiana's coastal marsh loss (for historic

loss) and predictions of potential future losses is merely an index rather than an absolute measure.

Three attributes of marsh loss are of particular interest: 1) how much loss has occurred; 2) over what time frame has the loss occurred; and, 3) what is/are the suspected reasons for the loss.

The NOD maintains a computerized GIS data base on land loss in coastal Louisiana (see Appendix D). The period of record for that data base is 1932 to 1990. Those data are time-sequenced and can be displayed on monitors or print-outs in map form depicting, in different colors, losses that have been recorded. NOD has recently published versions of those maps. The published as well as earlier draft versions were referred to when preparing this portion of this F-PHMEIS.

5.1.1.5. Analysis of NOD's HM permit data: Historic profiles and future without additional HM.

This section of the F-PHMEIS summarizes NOD's historic HM permit data. The reader is urged to refer to Appendix C for particulars and details. Appendix C consists of the basin-by-basin permit history narratives (C.1.), the raw and compiled data tables (C.2.) and the corresponding figures (C.3.).

Comments about permit history are derived from reviewing NOD's HM permit data base and should be regarded as a synoptic analysis of archived information.

References to sub-basins is as described in the Appendixes of the Louisiana Coastal Wetlands Restoration Plan: Main Report and Environmental Impact Statement (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993).

The Plates and Figures referred to are presented at the end of this section.

For the 19-year period 1977-1996 (January), NOD initiated evaluations of 121 permit applications for management (Appendix C). Twenty two (totalling 105,225 acres) were subsequently withdrawn from consideration before a final decision was rendered. One (for 520 acres) was denied. Only one application was pending a decision as of January 1996.

A total of 98 permits were issued for HM actions in Louisiana's coastal marshes by NOD (Appendix C). Based upon our findings relative to the status of those previously issued permits, we have determined that 71 projects have been/are presumed to be completed, partially implemented/im-

plementable (C/PI/I) in the hydrologic basins of coastal Louisiana described by Chabreck (1972) (Tables C.1. - C.8.), and later defined in a slightly different configuration (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). (NOTE: A PI project is one for which work has started but not completed, regardless of the status of the permit. No work has been initiated and the permit is still valid for an I project.)

Those 71 permitted projects encompass 495,020 acres (Table C.9.). The location of those projects is presented in Plates 1 through 8 (all eight Plates are located at the end of this section of the F-PHMEIS).

5.1.1.5.1. Delta Basins/Region

5.1.1.5.1.1. Pontchartrain Basin (Basin 1)

NOD has issued six permits, encompassing 37,490 acres (Table C.1., Plates 1 and 2). All stipulated WF/MR as the project purposes. The average size of the permitted projects was 6,248 acres.

The percentage of C/PI/I projects (C/PI/I) to permitted projects is 4/6 = 67 %. The percentage of completed projects to permitted projects is 1/6 = 16 %.

The percentage of C/PI/I acreage to permitted acreage is 31,648/37,490 = 84 %. The percentage of completed acreage to permitted acreage is 34 %. Incomplete project implementation encompasses 51 % of total acres permitted. The average size of the C/PI/I projects is 7,912 acres.

Only the one completed project (permit issued in 1988, MR/WF) encompassed an area that evidenced historic, measurable and documented conversion of interior marsh to open water, nearly all of which occurred during the 1956-1974 time frame.

For a perspective relative to marsh types and permitted management efforts, note that one recently issued permit encompasses 13,974 acres. The targeted marsh has evidenced some shoreline marsh loss but is substantially unbroken brackish vegetation. Continuation of ongoing shoreline erosion along Lake Borgne is perceived to be a potential problem at this site (a recently permitted WF/MR project). Failure to undertake some sort of shoreline erosion control efforts would seem to be in order. The targeted area encompasses about 43 % of the brackish marsh in the Pontchartrain/Land Bridge Sub-basin, 18 % of the 76,280 wetlands/pond acres of the sub-basin, 12 % of the 116,830 acres of Pontchartrain Basin's brackish marsh and 5 % of the

basin's total 267,760 acre-wetland/pond complex. Effects are most likely to be focused within or in close proximity to individual project areas. However, some interactive effects are possible. In the Pontchartrain/Borgne Land Bridge Sub-basin a permitted project adjoins the Bayou Sauvage NWR. Collectively, those two areas encompass more than half of the vegetated marsh and a substantial fraction of the water of the sub-basin. Additionally, a previously permitted project in the Middle Sub-basin could be dramatically influenced by a proposed Mississippi River water diversion project (i.e., Bonne Carre Diversion Project).

Government and corporate entities were the "typical" permittees. They pursued MR/WF projects that targeted areas with little or no recorded historic marsh loss, encompassed an average 6,248 acres, were to employ AMM to achieve the project purpose(s), and encompassed brackish or saltier marsh types.

No work, or partial project implementation, with subsequent permit expiration were the "typical" final outcomes for issued permits.

Monitoring was required for four of the six permitted projects. However, only one required monitoring report has not been submitted.

5.1.1.5.1.2. Breton Basin (Basin 2)

NOD has issued four permits, encompassing 13,572 acres (Table C.2., Plate 3). All were issued during the 1981-1982 time frame and all stipulated WF/MR as the project purposes. All four involved marshes with documented historic losses spanning the 1956-1990 time frame. The three no work/expired permitted project sites along the northern rim of Lake Leary could experience marsh loss in the future but could also be favorably affected by the freshwater/sediment supplied to the immediate area from Caernarvon. The average size of a permitted project was 3,393 acres.

The percentage of C/PI/I projects to permitted projects is 1/4 = 25 %. The percentage of partially implemented/implementable acreage to permitted acreage is 2,260/13,572 = 17 %.

The one partially implemented project represents 1 % of CWPPRA's estimate of Breton Basin's total marsh/pond area (184,011 acres), and about 2 % of the River aux Chene Sub-basin's brackish marsh/pond acreage. Therefore, there is no potential for interactive effects with other previously permitted HM projects and no potential to target one marsh

type over another. Effects are most likely to be focused within or in close proximity to that individual project area.

A government entity (n = 3, encompassing 11,312 acres) constituted the "typical" permittee. The "typical" permitted project was several thousand (3,393) acres, was to employ AMM to achieve project purpose(s), and encompassed brackish marsh that exhibited recorded marsh losses.

No work, and partial project implementation, with subsequent permit expiration, represented the "typical" outcomes for issued permits.

No monitoring was required for any permitted projects.

5.1.1.5.1.3. Barataria Basin (Basin 4)

NOD has issued 16 permits, collectively encompassing 242,514 acres (Table C.3., Plate 4). MR was the only stipulated purpose for five, WF the only stipulated purpose for two, and seven stipulated WF/MR as project purposes. Research was the stipulated purpose for two projects. The average size of permitted projects was 15,157 acres.

The percentage of C/PI/I projects to permitted projects is 13/16 = 81 %. The percentages of completed and partially implemented projects to permitted projects is 4/16 = 25 % and 7/16 = 44 %, respectively.

The percentage of C/PI/I acreage to permitted acreage is 225,351 acres/242,514 acres= 93 %. The percentages of completed and partially implemented acres to permitted acres are 4 % and 35 %, respectively. The average size of C/PI/I projects was 17,335 acres.

Three WF/MR project permits (encompassing 17,163 acres) were allowed to expire before any work was done. All three project areas exhibited marsh losses, primarily in the earlier periods of record and often associated with man's activities. The permits were issued in 1981, 1984 and 1991. Two of the projects (encompassing 13,590 acres) were located in areas where there is a perceived higher potential for future internal marsh loss or shoreline erosion than generally occurs elsewhere within the basin. Failure to implement these projects would seem to be opportunities lost to address historic as well as potential future marsh losses.

Seven projects have been partially implemented. Collectively, they encompass 85,999 acres. Four expired permits stipulated MR as at least one project purpose and

targeted brackish and/or saline marshes (encompassing 27,666 acres) that exhibited man-made and internal losses that occurred primarily prior to 1974. Two of these project areas (encompassing 14,676 acres) are located within areas where there is a perceived higher potential for future internal marsh loss or shoreline erosion than elsewhere within the basin. Failure to completely implement those two projects would seem to be opportunities lost by permittees to attempt to address historic as well as potential future marsh losses.

Three partially implemented projects for WF, WF/MR and MR are still active and target areas that have exhibited principally interior marsh losses at various times during the period of record. One of these, a WF/MR project, is located within an area where there is a perceived higher potential of future internal marsh loss or shoreline erosion than generally elsewhere within the basin. Failure to completely implement that project would seem to be another opportunity lost by a permittee to attempt to address historic as well as potential future marsh losses.

Two MR projects have been permitted (collectively encompassing 130,199 acres), remain valid, have not been started and target areas exhibiting marsh losses for various reasons during the period of record. Both project areas encompass locations where there is a perceived higher potential of future internal marsh loss or shoreline erosion than elsewhere within the basin. Failure to implement those projects may represent other opportunities lost by permittees to attempt to address historic as well as potential future marsh losses.

Only four projects are known (n = 3) or assumed (n = 1) to be completely implemented (collectively, 9,153 acres) for single purpose projects (MR, WF and two research projects). All four areas exhibited marsh losses but of different amounts that occurred primarily prior to 1983.

The 242,514 permitted acres represent 25 % of CWPPRA's estimate of the basin's total marsh/water complex (965,960 acres). Only the 140-acre project undertaken for research is located in an area where there is a perceived higher potential of future internal marsh loss or shoreline erosion than generally elsewhere within the basin. The results of the recently completed multi-agency study of MM at this location may be insightful when released for public use over the next several years.

The completed project acres represent 2 % of CWPPRA's estimate of that complex. The partially implemented projects represent 9 % of CWPPRA's estimate of that complex.

The C/PI/I acres represents 23 % of the basin's total wetland/water acreage. However, the actual marsh acres encompassed is higher because the above percentages include the areas of the basin's major bays.

In three sub-basins, instances of projects that can/do interact within and between sub-basins are apparent. In the other three sub-basins, there is no potential for interaction between completed/partially implemented projects.

Two projects collective encompass 41 % of the L'Ours Sub-basin's marsh/water complex. Two partially implemented projects encompass 44 % of the Central Marsh Sub-basin's marsh/water complex, about half of this sub-basin's vegetated wetlands.

There does not appear to be any trend towards disproportionate targeting of marsh types within sub-basins. Impacts and effects are most likely to be focused within or in close proximity to individual project areas. However, because there is a tendency to bring very large portions of some sub-basins under management for the first time, those impacts and effects have the potential to be manifest at the sub-basin scales.

Corporate (n = 7) entities may have been the numerically "typical" permittee but along with non-profit entities were "typically" associated with incompletely or partially implemented projects (79,749 acres/85,000 acres = 94 %). However, government entities (n = 4) were the "typical" permittee when total permitted acres are considered (142,739 acres/242,514 acres = 59 %).

Complete project implementation (n = 4; 9,153 acres) is an "atypical" outcome for issued permits.

Monitoring was required of 13 of the 16 permittees but only four submittals were received. Only three of the 10 corporate/non-profit permittees required to submit monitoring reports did so. A Federal government agency was the other permittee that submitted the required monitoring report. Non-submittals encompass 84,958 acres of all marsh types, and completed as well as incompletely implemented projects.

5.1.1.5.1.4. Terrebonne Basin (Basin 5)

NOD has issued 21 permits, collectively encompassing 50,763 acres (Table C.4., Plate 5). MR was the only stipulated project purpose for five, WF the only stipulated project purpose for three projects, WF/MR the stipulated project

purposes for 10, WF/MA the stipulated purposes for two, and RE was the stipulated purpose for one project. The average size of permitted projects was 2,417 acres.

The percentage of C/PI/I projects to permitted projects is 15/21 = 71 %. The percentages of completed and partially implemented projects to permitted projects is 8/21 = 38 % and 7/21= 33 %, respectively.

The percentage of C/PI/I acreage to permitted acreage is 40,825 acres/50,763 acres = 80 %. The percentages of completed and partially implemented acreages to permitted acreage are 46 % and 36 %, respectively. The average size of the C/PI/I projects was 2,722 acres.

The permittees for two WF/MA projects, a WF and three MR/WF projects allowed their permits to expire before any work was performed. Collectively, those permits encompassed 9,956 acres, targeted marshes that exhibited marsh losses during the 1956-1983 time frames and targeted fresh, intermediate and brackish marsh types. Three project areas (encompassing 5,577 acres; WF/MA =1, WF/MR = 2) are located in portions of the basin where there is a perceived higher potential for future internal marsh loss or shoreline erosion than generally elsewhere within the basin. Failure to implement those projects may represent opportunities lost by permittees to attempt to address historic as well as potential future marsh losses.

Seven projects have been confirmed (n = 3) or are assumed to be partially implemented (n = 4). Collectively, they encompass 18,215 acres, include WF, MR and WF/MR projects, target various amounts of the four marsh types, and encompass areas that exhibited various amounts of shoreline and/or interior marsh losses from earlier and/or more recent time frames. Generally, the MR and MR/WF permits were issued during a time frame during which losses were exhibited or shortly thereafter. For at least one MR project area and one MR/WF project area there is a perceived higher potential for future internal marsh loss or shoreline erosion than generally elsewhere within the basin.

Eight projects (WF-1, RE-1, MR-2 and WF/MR-4) have been completely implemented (confirmed) for permits issued from 1982 through 1991. They targeted fresh, intermediate and/or brackish marsh types, and generally encompassed areas that exhibited marsh losses- most of which were internal and occurred during the 1956 through 1983 time frames. Permit issuance tended to occur within a time frame during which losses had been recorded or the subsequent time frame. For all but one WF project, all of the other seven project areas encompass or are located within or near areas where there is

a perceived higher potential for future internal marsh loss or shoreline erosion than generally elsewhere within the basin.

The 50,763 permitted acres represent 4 % of CWPPRA's estimate of that basin's marsh/pond complex. The completed project acres represent about 3 % of CWPPRA's estimate of that complex. The partially implemented projects represent about 1 % of CWPPRA's estimate of that complex. The C/PI/I acres represents about 3.5 % of the basin's total wetland/water acreage. However, the actual marsh acres encompassed is higher because the above percentages include the areas of the basin's major bays.

All the permitted projects are within either the Penchant or Timbalier Sub-basins. Eight C/PI/I projects occur within and encompass 6 % of the Penchant Sub-Basin wetland/water complex. Seven completed/partially implemented/implementable projects encompass 3 % of the wetlands/water complex of the Timbalier Sub-basin.

There is no obvious potential for interactions between previously completed/partially implemented projects in either sub-basin. Effects are most likely to be focused within or in close proximity to individual project areas. Different impacts and effects are expected between the Timbalier and Penchant Sub-basins because they are comprised of substantially different proportions of fresh and saline marshes. However, there does not appear to be any trend towards disproportionate targeting of marsh types in either of the sub-basins.

Corporate (n = 9) entities were the numerically dominant permittee group and account for 37 % of the acres permitted. Private entities (n = 6) and government entities (n = 5) comprised the other major permittee groups and accounted for 21 % and 33 %, respectively, of the permitted acres.

Corporate (n = 3) and private (n = 3) permittees were the only permittees that allowed permits to expire without performing any work. Corporate permittees were equally likely to completely implement a permitted project (n = 4) as all other permittee groups combined (n = 4).

Monitoring was required of 17 of the 21 permittees. Of the eight completed projects, monitoring was required of seven, but only two monitoring reports were received, one from a corporate permittee and one from a Federal permittee. Of the seven partially implemented projects only one of the six required monitoring reports submitted.

5.1.1.5.1.5. Atchafalaya Basin (Basin 6)

No permits for HM have been issued in this basin (Table 5).

5.1.1.5.1.6. Teche-Vermilion Basin (Basin 7)

NOD has issued 16 permits, collectively encompassing 56,476 acres (Table C.6., Plate 6). MR was the only or a stipulated purpose for 14 and WF the only stipulated purpose for two. The average size of the permitted projects was 3,530 acres.

The percentage of C/PI/I projects to permitted projects is 12/16 = 75 %. The percentages of completed and partially implemented projects to permitted projects are 7/16 = 44 % and 2/16 = 13 %, respectively.

The percentage of C/PI/I acreage to permitted acreage is 54,493 acres/56,476 acres = 96 %. The percentages of completed and partially implemented acreages to permitted acres are 19,968 acres/56,476 acres = 35 % and 4,525 acres/56,476 acres = 8 %, respectively. The average size of the C/PI/I projects was 4,541 acres.

Permittees for one WF and three MR/WF projects (collective encompassing 1,983 acres) allowed their permits to expire before any work was performed. The WF and one of the MR/WF project areas exhibited no recorded marsh loss.

Permittees for two MR/WF projects (collectively encompassing 1,440 acres) targeted areas that exhibited marsh losses that generally occurred during the 1956-1983 time frames but allowed their permits to expire before their projects were fully implemented.

The remaining MR project and MR/WF projects targeted areas that exhibited man-made, internal and shoreline losses that occurred at different times.

Eight projects have been completely implemented (confirmed), encompassing 19,968 acres. They target fresh, intermediate and brackish marsh types and areas that have exhibited marsh losses that occurred for various reasons at various times. More often (n = 5) than not (n = 3) the permit was issued within the time frame during which recorded losses occurred.

Only three C/PI/I projects are clearly located within or encompass areas where there is a perceived higher potential for future marsh losses, predominantly as a result of shoreline erosion. Collectively, these three WF/MR projects encompassing 8,355 acres. Two of the projects are complete. The third has been partially implemented and the permit has expired....apparently an opportunity lost by the permittee to attempt to address historic as well as potential future

marsh losses.

The permitted acres and C/PI/I acres each represent about 19 % of CWPPRA's estimate of that basin's wetland/water complex. The completed project acres represents 7 % of the basin's wetland/water complex. The partially implemented acres represents about 1.5 % of the basin's wetland/water complex. The actual marsh acres encompassed is higher because the above percentages include the areas of the basin's major bays.

The Cote Blanche Bays Basin (encompassing 56,333 wetland/water acres) involves 33,218 permitted and 33,085 C/PI/I acres, or about 59 % of the sub-basin's wetland/water complex. One project (30,000-acre implementable project) represents 53 % of the sub-basin's wetland/water complex. The Vermilion Sub-basin (encompassing 164,432 wetland/water acres) involves 22,658 permitted acres and 21,318 C/PI/I acres, or about 14 % of the sub-basin's wetland/water complex.

Within each of the sub-basins, effects are likely to be focused within or in close proximity to individual project areas. However, interactions between previously completed/partially implemented projects are possible. What's more, the Cote Blanche Bay Sub-Basin is almost exclusively comprised of fresh marsh whereas the Vermilion Bay Sub-basin is overwhelming comprised of intermediate and brackish marsh types. Accordingly, significant differences in marsh type proportionalities between the two sub-basins strongly suggests a potential for quite different impacts from management efforts.

Corporate (n = 7) and private (n = 7) entities were the numerically dominant permittee groups but accounted for only 46 % of the permitted acres. The two government entities account for 54 % of the permitted acres.

Corporate permittees were about as likely to completely implement a project (n = 4) as they were to let a permit expire with no work being done at all (n = 3), and less likely to partially implement a project (n = 1). Private permittees had a similar record.

Monitoring was required of nine (56 %) of the 16 permittees. Of the eight completed projects, five required monitoring but only three reports were received (two corporate permittees, one private permittee).

5.1.1.5.1.7. Delta Region Summary

NOD issued 63 permits for HM efforts in this region. Those 63 permits encompassed 400,815 acres (uncorrected for overlap). However, only 45 C/PI/I HM projects occurred within the region. Collectively, those 45 permitted project areas encompass 354,577 acres (corrected for overlap), representing 89 % of the 400,815 permitted acres for HM within the Delta Region (Tables C.9. - C.14.)

Corporate, private and government entities received 29, 18 and 16 permits, respectively.

Corporate, private and government permittees were very similar regarding the completion of permitted projects (38 %, 28 % and 31 %, respectively). However, private and government permittees tended to allow a permit to expire with no work being done (33 % and 38 %, respectively) slightly more often than corporate permittees (21 %). Government permittees tended to either complete a permitted project (31 %) or let the permit expire without any work being done (38 %). In contrast, corporate and private permittees exhibited a tendency to start work on a project and allow the permit to expire 21 % and 17 % of the time, respectively.

A total lack of private permittees in the Pontchartrain and Breton Basins compared with the participation of those permittee groups in the other three Delta Basin was surprising considering that marsh is being lost and waterfowl interests do occur in those basins. In the other three basins, private and government permittees (n = 28) only slightly outnumber the number of corporate permittees (n = 25). Clearly corporate permittees represent the bulk of the permit activity in this region.

In general, if a permit was issued, some effort to implement the project was taken. That was especially true in Delta Basins 4, 5 and 7. In Basin 3 (Barataria) as well as Basin 7 (Teche-Vermilion) a single, large, recently permitted project accounts for nearly all of the implementable acreage. Because both are authorized CWPPRA projects, the number of completed/partially implemented acres should increase substantially in those two basins, and thus in the region as well.

Permittess in Basins 1, 2, 5 and 7 pursued projects that averaged between about 2,000 and 5,000 acres. Pemittees in Basin 4 pursued projects that averaged more than double that size.

All permittee groups evidenced about the same project completion/partial implementation rates. However, corporate and government permittees generally attempted larger projects in nearly all basins, which is why the average size of completed/partially implemented projects is larger than the average size of permitted projects.

The stipulated reasons for initiating the implementation of permitted HM projects in Basins 1 and 2 (MR/WF) may not have been as compelling as they were (typically MR/WF and/or MR) to permittees in Basins 4, 5 and 7. As a result, the Delta Region's permit history and consequent effects were/are largely driven by HM efforts in Basins 4, 5, and 7. Partial implementation with permit expiration (10 permits) occurred in all Delta basins regardless of permittee group (corporate, private or government). Typically, it occurred more often with corporate permittees (n = 6) than with private (n = 3) or government (n = 1) permittees. MR/WF was the generally stipulated purpose and the project tended to target brackish or saltier marsh types that exhibited older rather than newer (within the last ten years) instances of loss.

Issuance of a permit, with or without a provision to monitor, didn't seem to be related to a project's final disposition. For completed projects that required monitoring, the submittal rate is slightly less than 50 %.

5.1.1.5.2. Chenier Basins/Region

5.1.1.5.2.1. Mermentau Basin (Basin 8)

Of the 20 permits NOD issued, only 17 where for HM within the basin boundaries (Table C.7., Plate 7). Those 17 permits encompassed 49,531 acres. The average size for these permitted projects was 2,914 acres. One permit for an 800-acre WF(FB) project was allowed to expire without any work being done.

The 16 C/PI/I permits within the basin encompass 48,731 acres. MR was the single stipulated purpose for five permits, WF the single stipulated purpose for three permits. WF(FB) was the stipulated purpose for two projects, and WR/WF were the stipulated purposes for six permits. The average size of the C/PI/I projects within the basin was 3,045 acres.

The percentage of C/PI/I projects to permitted projects is 16/17 = 94 %. The percentages of completed and partially implemented projects to permitted projects is 11/17 = 65 % and 4/17 = 24 %, respectively.

The percentage of C/PI/I acreage to permitted acreage is 48,731 acres/49,531 acres = 98 %. The percentages of completed (34,097 acres) and partially implemented (11,934 acres) acreages to permitted acres are 69 % and 24 %, respectively.

Only one permittee for a WF(FB) project (1991; 800 acres F/I marsh) allowed the permit to expire before any work was done. The area exhibited marsh gain, and a goal of that project was to reverse that trend.

No work has begun on a recently issued MR project. Work was started on three MR/WF projects but not completed before the permits expired. The three MR/WF project areas collectively encompassed 11,934 acres, and involved the fresh, intermediate and brackish marsh types. These three permits were issued within the time frames during which losses were recorded, but only one (encompassing 6,296 acres) was in an area where there is a perceived higher potential for future marsh losses. Failure to completely implement the project may be an opportunity lost for the permittee to address historic as well as future losses. However, the project is expected to benefit from a functioning freshwater diversion project (see Vermilion P w/l 285).

Work was completed on four WF, four MR and four MR/WF projects. Collectively they encompass 34,397 acres. Only one WF project and one MR/WF project targeted areas that exhibited little if any marsh losses during the period of record. Elsewhere, losses varied in extent but the permit issuances occurred soon after or during periods when marsh losses were recorded. Of these 12 completed projects, only three of the MR projects and one of the MR/WF projects (collectively accounting for 17,370 acres) clearly encompassed or were in or near areas where there is a perceived higher potential for future internal marsh losses or continued shoreline erosion.

The permitted acres and the partially implemented/implementable acres represent 7 % and 2 %, respectively, of the basin's wetland/water complex. The completed acres represent about 4 % of the basin's wetland/water complex. However, the percentages would be are higher if corrections for the large lakes were made. Nonetheless, targeted marsh types seem to be proportionally similar to the amounts of each marsh type in the basin's two sub-basins.

The position of implemented/partially implemented/implementable projects one-to-another in the Lakes Sub-basin suggests little potential for interactions and that effects would be focused within or in close proximity to individual project areas. However, there is a potential for localized

interactive effects between permit clusters in the Chenier Sub-basin.

Corporate (n = 8; 34,304 acres) and government entities (n = 4; 11,924 acres) accounted for nearly 95 % of the permitted acres and 9 of the 12 completed projects. Corporate permittees also account for all three projects that were partially implemented before the permits expired.

Monitoring was required of 11 (69 %) of the 16 permittees. Only seven monitoring reports (7/11 = 64 %) have been received.

In this basin, final permit disposition seems to be related to permittee group and project areas with histories of marsh loss about equally well, but are much more weakly linked to future losses.

5.1.1.5.2.2. Calcasieu-Sabine Basin (Basin 9)

Collectively, NOD and the Galveston District of the Corps of Engineers have issued 17 permits in and near this basin (Table C.8., Plate 8). Those 17 permits encompass 105,715 acres. Two (encompassing 7,449 acres) were issued for projects outside the basin boundaries. The 15 permitted HM projects within the basin encompass 98,266 acres. The average size of these projects was 6,615 acres.

Of those 15, one (MR/WF, targeting 400 acres) was essentially a fresh water diversion project. One of the remaining 14 projects was a MR/WF project of 1,000 acres nested within a previously permitted project area. Of the 13 remaining HM projects (encompassing 96,866 acres), three (WF = 1, WF/MR = 2) have expired with no work being done (5,154 acres), and all three targeted areas that exhibited marsh losses but different amounts during different time frames. Generally, those permit issuance occurred during or in the time frame subsequent to the most recently recorded marsh losses.

The 10 remaining HM projects encompass 91,712 acres. The average size of these 10 projects was 9,171 acres.

MR was the only stipulated purpose for two projects, WF (to include furbearers) the only stipulated purpose for four projects, and WF/MR were the stipulated purposes for four projects.

The percentage of the 10 C/PI/I HM projects to the 14 permitted HM projects is 71 %. The percentages of completed and partially implemented projects to permitted HM projects is 6/14 = 43 % and 3/14 = 21 %, respectively.

The percentage of C/PI/I acreage (n = 10) to permitted HM acreage (n = 13) is 91,712 acres/96,866 acres = 95 %. The percentages of completed and partially implemented acreages to permitted acres are 17,253 acres/96,866 acres = 18 % and 73,259 acres/96,866 = 76 %., respectively.

Permittees for a MR and a MR/WF project (collectively encompassing 66,035 acres) let their permit expire before their projects were completed. All the targeted areas exhibited marsh losses but different amounts during different time frames. Also, permit issuance occurred during or in the time frame subsequent to the most recently recorded marsh losses. Generally, the permitted projects targeting marsh in the west-central and southwestern rim of Calcasieu Lake encompassed or were in or near areas where there is a perceived higher potential for future internal marsh losses or continued shoreline erosion.

Work was completed for six projects (confirmed = 5, assumed = 1; encompassing 17,253 acres). Three were WF projects (encompassing 7,455 acres). The other three were MR/WF projects (encompassing 9,798 acres). One 35-acre WF project exhibited no measurable marsh loss. All other project areas exhibited extensive losses, nearly all of which occurred prior to 1974. Thus, permit issuances occurred as little as nine but as much as 18 years after the last measurable marsh losses were recorded.

The permitted acres and partially implemented acres represent 17 % and 13 %, respectively, of the basin's wetland/water complex. The completed acres represents 3 % of the basin's wetland/water complex.

The Calcasieu-Sabine basin can be thought of as consisting of two sub-basins. All four marsh types occur in the East-of-Calcasieu Lake Sub-basin and permits issued for management efforts in this sub-basin probably encompass between 50 and 60 % (estimate) of the wetlands/water complex.

All four marsh types also occur in the West-of-Calcasieu Lake Sub-basin. Management efforts undertaken by the Sabine NWR in the central and eastern portion of this sub-basin and permitted management efforts located primarily in the eastern portion have encompassed extensive portions of the eastern half-of this sub-basin. Interaction and interdependencies and nested projects occur. Management efforts in the western portion of this sub-basin have not been nearly as extensive but have been associated with the Sabine NWR. Only one 1,200-acre management project has been permitted in the western portion of this sub-basin.

Corporate (n = 8) and government entities (n = 2) account for 95,866 of the 96,866 permitted acres (99 %). Private permittees (n = 3) encompassing 870 acres (1 %).

Monitoring was required of 10 (77 %) of the 13 permittees. Only four (40 %) monitoring reports have been received. Two private, one government and one corporate permittee submitted the required reports.

5.1.1.5.2.3. Chenier Region Summary

Of the 37 permits NOD issued, only 31 were for HM efforts in this region. Those 31 encompassed 151,497 acres (uncorrected for overlap). However, only 26 C/PI/I HM projects occurred within the region. Collectively, the 26 (26/31 = 84 %) projects encompassed 140,443 acres (corrected for overlap), and represented 93 % of the 151,497 acres permitted for HM within the Chenier Region (Table C.9.).

Corporate, private and government entities received 15, nine and seven permits, respectively.

Project completion by all permittee groups exceeded 50 % - 53 %, 67 % and 71 % for corporate, private and government permittees, respectively. Corporate and government permittees each involved considerably more acres than did private permittees. Partial project implementation with subsequent permit expiration occurred as a confirmed outcome only by corporate permittees in the Mermentau Basin (encompassing 5,638 acres). Corporate entities, unlike any other permittee group, allowed permits to expire with no work being done (encompassing 5,154 acres).

Completion of a project accounted for 17 of the 30 total permits issued for HM efforts in this region, a completion rate of 57 % (encompassing 51,350 acres - 26 % of the 196,866 permitted acres). However, some work was performed or is under way on a total of 24 (80 %) of the 30 permitted projects (encompassing 136,543 acres, 93 % of the 146,397 permitted acres).

The stipulated reason(s) for undertaking a project (typically MR/WF and or MR) were compelling. If a permit was issued, the permittee made an attempt to implement the project.

Marshes targeted for management typically exhibited historic losses but for a variety of reasons. Those same targeted marshes didn't always encompass, include, or occur near areas where there is a perceived higher potential for future internal marsh losses or continued shoreline erosion.

The average size of the completed/partially implemented projects is just slightly larger than the average size of a permitted project because the four projects whose permittees allowed the permits to expire before staring work only collectively involved 5,954 acres.

Issuance of a permit, with or without a provision to monitor, didn't seem to be related to a project's final disposition. For completed projects that required monitoring, the report submittal rate was nearly 70 %.

5.1.1.5.3. Coastwide

The number of C/PI/I projects each year has remained fairly constant for projects that, on average, have tended to become smaller (Figure C.1., Table C.9.). Overall, C/PI/I projects have averaged about 6,972 acres. While the average size of C/PI/I projects varies between years, the cumulative number of C/PI/I projects continues to rise (Figure C.2., Table C.9.). The influence of large projects on acreages was noticeable.

Several permits were included in the raw permit data base that authorized activities or structure installations, operations and maintenance that aren't properly classified as marsh management or hydrologic management efforts. Historic use of the term "marsh management" as an umbrella term could account for that finding.

Permitted project areas do overlap. Dual permitted acreage, however, encompasses about 10 % of the total permitted acreage.

Throughout coastal Louisiana, AMM was perceived to be effective at achieving WF and/or MR restoration goals because it was pursued by all permittee groups, largely without regard for project purpose, project size, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

Prior to 1984, WF was the leading reason to undertake a MM project (Figure C.4. - C.7.; Tables C.18. & C.19.). Since then, WF has consistently been the third leading reason. For the period 1984-1989, MR and MR/WF were pursued as project purposes in about equal proportions. As of 1990, MR has emerged and continues to be the predominant single purpose for undertaking HM projects. Therefore, questions about what HR, an evolved form of MM, could be expected to do regarding MR were apparently properly timed and well founded considering the amount of acreage already involved at that time.

The focus of the historic permit activity has been in Basin 4 of the Delta Region and Basin 9 of the Chenier Region (Figures C.5. - C..7, Tables C.12. - C.14.). Over all basins, project patterning suggested that projects addressed individual, site-specific management interests. However, only in Basins 4 and 9 does the extent of involved acres and project patterning suggest that impacts and effects on hydrology extend much beyond the footprints of individual projects with consequent effects on other marsh system significant attributes.

In almost every year, C/PI/I projects included the brackish marsh type, whether individually or in combination with other marsh types (Figs C.8. and C.9., Tables C.20. and C.21.).

Figure C.10. (Tables C.15. - C.17.) displays the relationship between the stipulated reason(s) for management and the type of marsh(es) encompassed within the permitted management efforts. Several points are noteworthy:

1) MR efforts encompass the widest range and most acres of included marsh types. WF efforts encompass the narrowest, focusing on marsh types up to and including brackish. MR/WF efforts fall between the two single project purposes.

2) When WF was the single stipulated purpose there was a tendency to encompass more of the fresh marsh type. Eight (67 %) of the 12 permits issued for waterfowl encompass 60,525 acres (89 %) of the 67,779 acres permitted for WF only projects.

3) Regardless of purpose, 42 (59 %) of the 71 C/PI/I permits issued encompassed brackish marsh. Collectively, they involved 390,362 acres (79 %) of the 495,020 C/PI/I acres. However, C/PI/I projects tend to include brackish marsh when MR is the single stipulate purpose [13 (72 %) of 18 permits].

4) Reference Figures C.8. - C.13. (Tables C.10. and C.11.), encompassing more than one marsh type within a management effort has been the pre-eminently common practice (347,485 acres of 495,020 acres - 70 %), recorded across both regions as well as basins within regions. The practice of including multiple marsh types has not appreciably diminished over the years. The practice accounted for about 70 % of the C/PI/I acreage.

Differences exist between sub-basins, basins and regions. The two Delta basins east of the Mississippi River have been

targeted infrequently for HM efforts, despite historic and on-going marsh losses and waterfowl interests. Basin 4 exhibits a more encompassing pursuit of HM that involves some if not most of many sub-basins and focusing on MR. Basins 5 and 7, comparatively, evidence primarily site-specific pursuits of HM. The potential for interactions with pre-existing managed areas is apparently much greater in Basin 4 and 7. The Chenier basins are alike in that much of the basins' marsh/water complex have been or are under some form of HM management and the historic HM effort resulted in expanding the amount of marsh under management. In Basin 9, however, the initiative encompassed or in several cases was intended to influence conditions within or adjacent to portions of the Sabine NWR.

In all basins, property boundaries, rather than hydrologic patterning, appeared to define the limits of project areas. Also, many of the C/PI/I projects in the Delta basins are situated in locations that were characterized as poorly supporting the installation of water control structures and levees and/or exhibiting some of the highest subsidence rates within coastal Louisiana (Cahoon and Groat's 1990, Plate 8).

Additionally, over all basins, projects tended to target areas where there had been some marsh losses. Areas were targeted where old as well as more recent losses had been recorded and somewhat independent of the cause of loss. Considerably fewer projects included areas where there was a perceived higher potential for future losses. Historic management efforts were reactive....because they focused considerably more on addressing past rather than addressing potential future losses.

Although averages have been computed (Figures C.14. - C.16., Tables C.19. - C.21.) and referred to, they cannot be used to consistently and reliably address impacts and effects. For example, a single large project in each of two basins (Basin 4 - 123,000, Basin 9 - 66,000) dramatically elevated the average project size in those basins relative to all other basins. And, the distorting effect of vastly different projects sizes in small data sets was even more dramatic when only two or three projects represented the total response for a year, cover type or management purpose. Thus, number of permits, total acreages and percentages are reported.

Corporate entities (typically with extensive land holdings) and government entities account for the vast majority of permittees and collectively account for most of the acreage brought under management. The prominent role of local government entities as permittees in Basins 2 and 9

distinguished those basins from all others.

Unimplemented and partially implemented projects whose permits have expired can be viewed as missed opportunities for permittees, be they landowner(s)/leaseholder(s) or government entities, to attempt to address historic marsh losses, manage the habitat of targeted animal species and perhaps forestall future marsh losses. Additionally, permit applicants were prone to expressing displeasure at the time it took to get a permit. Therefore, it was surprising to discover that a relatively high proportion of permits (20/95 = 21 %) were allowed to expire without any work being done and partial implementation of a project followed by permit expiration also involved a considerable acreage. These findings suggests that: 1) project purpose may not be limited to the ones stipulated; 2) project purposes change after permit issuance; and/or 3) circumstances controlling the implementation/completion of the project are fluid.

Included marsh type, project area size, the inclusion or lack of monitoring requirements, basin, region or permittee group appeared were not attributes that could be used universally to predict the final fate of a permit issued for HM.

Accordingly, the reason(s) why permit issuance doesn't equate directly to project implementation, and partial implementation occurred coastwide, are unknown but could be the subject of future investigations. Those permit outcomes could be artifacts of NOD's permit data and/or NOD's permit follow-up process. However, if the permit and follow-up data are reasonably accurate, then they could reflect many things. For example, the different corporate and private/governmental implementation profiles suggest that: 1) some permittees would seem to disagree with Federal and state regulators about what was really necessary to achieve applicant-stipulated purposes; 2) unstipulated purposes could have been as compelling, or more so, than the stipulated purposes for some permittees; and, 3) the circumstances that would suppress implementation (e.g., uncertain construction schedules, rising costs and/or interest rates making other uses for the money more profitable, certainty of funding sources, whether or not the money is irreversibly dedicated) disproportionately influence corporate and government permittees. A more detailed analysis may reveal other explanations.

Potential consequences of partial and incomplete project installations are that:

A) beneficial MR, and/or WF, expectations attributable to the pool of permitted HM efforts -

1) cannot be fully realized, because they

2) are limited to only fully implemented projects

3) and in all likelihood will not be fully realized without subsequent permit/regulatory action;

4) could include detrimental, possibly destructive (some may be irreversible if dreding of marsh is involved) effects to some significant biological attributes

B) the structure and function of marshes where projects have been initiated but only incompletely implemented have been unavoidably altered, in a manner -

1) that remains to be defined and quantified

2) not portrayed by permit applicants as a reasonably foreseeable possible outcome, and

3) not previously anticipated as a reasonably foreseeable outcome during permit application evaluations, and

4) that could preclude realizing many of any beneficial MR, and/or WF, expectations without subsequent permit/regulatory action

The historic permit data base was virtually mute about the success any appreciable number of permitted project achieved relative to stipulated project purpose(s). Thus, the effectiveness of historic, permitted HM efforts to address marsh losses (that occurred 10, 20 or even 30 years ago for a variety of reasons) and/or affect the habitat of overwintering waterfowl numbers cannot be answered with the permit data base.

Without subsequent data collections, efforts to comprehensively forecast site-specific as well as broader scale impacts and effects arising from C/PI/I projects is reduced to a largely theoretical exercise.

Attention to permit issuances at sub-basin levels appears warranted.

5.2. **Profiles of Candidate CWPPRA HM Projects**

The reader is urged to refer to Appendix Q for narrative descriptions of individual CWPPRA projects. Those

descriptions served as the source for the summaries that follow.

5.2.1. Delta Basins/Regions

5.2.1.1. Pontchartrain

Four candidate CWPPRA HM projects are assumed to be viable candidates for future implementation (Plates 1 and 2, Tables Q.1., Q.7. and Q.13., Figure Q.1.). One has already been permitted and discussed under that heading. Collectively, the other three could encompass 13,170 acres. Of that total, 9,255 previously unmanaged acres could be brought under management and the on-going management of 3,915 acres could be sustained.

All four candidate projects are intended to slow marsh losses, invigorate existing marsh and expand the amount of submerged aquatic vegetation. Historic and continued interior marsh losses are perceived as concerns for two project areas and continued shoreline losses are perceived as concerns in three of the four project areas.

HR (passively operated) would be the management option of choice to sustain the management of two areas (5,170 acres). HR (actively operated) was the management option of choice applied to a 15,578-acre previously permitted project. None of the HR projects have yet stipulated the point in time that represents the historic situation to be emulated. MM (active) would be the management option of choice to establish a first-time management presence on one 8,000-acre project area.

The projects exhibit a disconnected spatial relationship to one another (Plates 1 and 2). However, the two projects in the Pontchartrain/Borgne Land Bridge Sub-basin would collectively account for 19,593 acres (26 % of that sub-basin's marsh/water complex) and have impacts and effects in excess of that acreage because of the substantial amount of wetlands/water already under management (e.g., Bayou Sauvage NWR). Elsewhere, the impacts and effects of the other two projects are more likely to occur within or in the immediate vicinity of each project area.

5.2.1.2. Breton

There are no CWPPRA MM or HR projects planned in this basin.

5.2.1.3. Barataria

Nine CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 4; Tables Q.2., Q.8. and

Q.13.; Figure Q.1.). Three have already been permitted and discussed previously. Two of the three are large-scale and long term. They have proven to be difficult to fully implement. Included smaller projects represent site-specific efforts to address management issues until the larger projects can be implemented and adjustments made to included projects.

Collectively, the remaining seven could encompass 60,888 acres. Of that total, 58,340 previously unmanaged acres could be brought under management and the management of 2,548 acres could sustained.

Seven projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. The two others have arresting shoreline erosion as a purpose. All nine areas have exhibited internal marsh losses during the period of record and shoreline losses have occurred at two project areas.

HR would be the management option of choice for seven of the nine project areas, collectively encompassing 145,705 acres. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. MM would be the management option of choice for two targeted areas (encompassing 29,498 acres of brackish and saline marsh/water). HR is apparently perceived to be implementable over fresh, intermediate and/or brackish marsh types, whether or not the management would be active or passive and regardless of the size of the project area.

The projects exhibit several spatial relationships to one another (Plate 4). Therefore, it is possible, even probable, that several of the projects could exert an influence on adjacent or nearby projects, and a certainty that pre-existing projects would be affected when located within the boundaries of larger projects. What's more, the candidate CWPPRA HM projects would encompass most of the western wetlands/water complex of the Bay, North Bay, Central Marsh and Salvador Sub-basins (Plate 4).

5.2.1.4. Terrebonne

Twenty-two CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 5; Tables Q.3., Q.9., Q.13.; Figure Q.1.). However, only 18 are included in this discussion. Collectively, they encompass 189,171 acres.

Of that total, 135,050 previously unmanaged acres could be brought under management for the first time (n = 14 projects), the management of 38,444 acres would be sustained

(n = 2 projects) and management capability would be reacquired over 20,677 acres (n = 2 projects). Nearly all projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. One intends to forestall the onset of saltwater intrusion and two are designed to freshen marsh. Nearly two-thirds of the projects areas exhibited losses that spanned the period of record. However, the other of the projects exhibited losses which occurred predominantly prior to and through the 1974-1983 time frame and it these project areas, collectively encompassing 65,458 acres of all four marsh types, that comprise almost half of the total area to be brought under management for the first time.

Active forms of both HR and MM would be the predominant management options of choice. Most of these projects call for the construction of new perimeter water control features. Actively and passively operated HR and actively operated MM are apparently perceived to be implementable regardless of included marsh type, whether or not the management would be active or passive and regardless of the size of the project area, and independent of the extent and timing of the targeted losses.

The projects exhibit several spatial relationships one-to-another (Plate 5). Therefore, it is possible, even probable, that several of the projects could exert an influence on adjacent or nearby projects. Furthermore, the candidate CWPPRA HM projects would encompass most of the wetlands/water complex of the Timbalier and Penchant Sub-basins (Plate 5).

5.2.1.5. Teche-Vermilion

Five CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 6; Tables Q.4. Q.10, and Q.13.; Figure Q.1.). One (30,000 acres) has already been permitted. Collectively, the remaining four projects encompass 14,643 acres. Of that total, 2,181 previously unmanaged acres could be brought under management, the management of 12,062 acres could be sustained and a management capability could be reacquired over 400 acres.

All five project areas exhibited shoreline erosion throughout most or all of the period of record. One project includes reduction of internal marsh losses as a purpose. Another is intended to reacquire management capability.

All five projects would use HR to achieve project goals, but an active approach would predominate. Most of the projects call for the construction of new perimeter water control features. HR is apparently perceived to be implementable

over fresh, intermediate and/or brackish marsh types, whether or not the management would be active or passive, regardless of the size of the project area, and independent of the reason for, extent of and timing of the targeted losses.

The projects exhibit a disconnected spatial relationship one to one another (Plate 6). Thus, the effects of the three other projects are more likely to occur within or in the immediate vicinity of each project area. However, the impacts and effects of the 30,000-acre project in the eastern marshes of the basin were already discussed in the permit profiles of the basin.

5.2.1.6. Delta Region

The candidate CWPPRA HM projects would subject 207,479 formerly unmanaged acres to predominantly HR (Figures Q.1, Q.4., Q.8.; Tables Q.13. - Q.15.) across all basins and virtually without regard to include marsh type(s). Sustaining existing management capabilities (56,969 acres) and reacquiring prior management capabilities (13,424 acres) are clearly subordinate means to achieving project purposes.

Candidate CWPPRA HM efforts would tend to encompass more than one marsh type and target intermediate and/or brackish marsh.

At this stage of project development, the connection is not always readily apparent between the marsh loss problems and the proposed management solutions for several projects. Subsequent evaluations performed during advanced project design and NEPA compliance reviews should clarify the linkage and may reveal implementable alternative approaches for all projects.

5.2.2. Chenier Basins/Region

5.2.2.1. Mermentau

Ten CWPPRA HM projects were assumed to be viable candidates for future implementation (Plate 7; Tables Q.5., Q.11. and Q.13.; Figure Q.2.). However, one (PME-14) was permitted and one permit (ME-2) was denied. Collectively, the eight encompass 41,140 acres. Of that total, 14,381 previously unmanaged acres could be brought under management, the management capability would be reacquired on 12,250 acres and the management capability would be sustained on 14,509 acres.

All the projects are multi-purposed. Three have control of loss, either internal (n = 2) or shoreline (n = 1), as at

least one purpose. The other projects all share the goal of enhancing biological productivity of the targeted areas. All the project areas have exhibited marsh losses. The extent of those losses and the time frames in which the losses were most extensive varied. Losses as recent as the 1983-1990 time frame have been recorded in some areas. HR would be the management option of choice for seven of the eight project areas, collectively encompassing 33,840 acres. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. One project would sustain an active MM effort encompassing 7,300 acres. HR is apparently perceived to be implementable over all four marsh types, whether or not the management would be active or passive, regardless of the purposes of the projects, and regardless of the size of the project areas.

For the most part, the projects exhibit a disconnected spatial relationship to one another (Plate 7). However, it is possible, even probable, that the projects clustered south of Grand Lake and astride the Mermentau River may be interdependent to a degree related to river hydrology. What's more, the proximity of those three projects could have interactive effects with an upstream previously permitted project. Much of the western and central portions of the Chenier Sub-basin have been managed for years. In contrast the marshes/water in the southeastern and eastern portions of that sub-basin represent that bulk of the remaining unmanaged marsh/water in the sub-basin. Projects XME-46 and ME-4 collectively target much of that marsh and could also be expected to have interactive effects with adjoining permitted project areas. Elsewhere, the impacts and effects of the other four projects are more likely to occur within or in the immediate vicinity of each project area.

5.2.2.2. Calcasieu-Sabine Basin CWPPRA HM Projects

Forty-three CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 8; Tables Q.6., Q.12. and Q.13.; Figure Q.2.). Several have been previously permitted but even more represent site-specific management efforts nested within the footprints of other larger candidate management projects. Thus, 28 individual projects were identified. Collectively, they encompass 232,534 acres. Of that total, 150,234 previously unmanaged acres could be brought under management and the management capability would be sustained on 82,300 acres.

Even with the expanded base of information available in the Calcasieu-Sabine Basin Plan (NRCS 1992), at this stage of project development, the connection is not readily apparent between the marsh loss problems and the proposed management

solutions for several projects. Subsequent evaluations performed during advanced project design and NEPA compliance reviews should clarify the linkage and may reveal implementable alternative approaches for all projects.

Much more than half of the projects are intended to improve conditions for aquatic plant growth and/or prolonging the existence of remaining marsh vegetation in targeted areas. Some also have as a goal control of wind-induced wave caused erosion of shorelines/remaining marsh within targeted areas. Areas that haven't exhibited some marsh losses during the period of record would represent a deviation from the norm. Nearly all of those areas are in the southwestern portion of the western sub-basin. The vast majority of the recorded marsh losses occurred during the 1956-1974 time. Losses of interior marshes during the 1974 - 1990 time frames were much more site specific (generally east and immediately northwest of Calcasieu Lake and in the central portion of the western sub-basin).

HR would be the management option of choice for most of the candidate projects, collectively encompassing 259,354 acres. Rock weirs would be used extensively because the soils are thought capable of supporting them. MM would be the management option of choice for 102,393 acres, most of which reestablish former or prolong on-going management efforts. MM and HR are apparently perceived to be implementable over all marsh types, whether or not the management would be active or passive, regardless of the size of the management area and regardless of when the loss occurred.

Nowhere else in the coastal zone and nowhere on such a scale is there such an extensive effort to bring nearly every acre of a sub-basin under some form of HM. As a result, the tidal signals within every one of the candidate managed areas would be only partially reflective of the rhythm and dynamics of the tidal signal in the unmanaged portion of the estuary. In some areas, there may be little if any tidal signal, given the nesting of projects. Thus, differing degrees of reduced tidal signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to slowing/stopping/reversing internal marsh losses, invigorating existing marsh and expanding the amount of submerged aquatic vegetation. For some projects, intentionally inducing hydrologic differences would apparently be a separate way to add to benefits derived from arresting shoreline erosion.

In this basin more so than any other, some projects may be more influential than others. Projects located along and targeting perimeter marshes should be assumed to have

secondary effects on more internal marsh/water areas. An in-depth assessment of existing and potential hydrologic interactions/inter-dependencies would be most insightful for more precisely forecasting effects to significant attributes.

5.2.2.3. Chenier Region

The candidate CWPPRA HM projects would subject 164,615 formerly unmanaged acres and 96,809 currently managed acres to predominantly HR (Figures Q.2., Q.4. Q.8.; Tables Q.13., Q.14., Q.16. and Q.17.).

In both basins the tendency is to sustain or reacquire management of areas consisting of fresh and/or intermediate marsh types and to target intermediate and saltier marsh types for first-time management.

Overwhelmingly, HR would be the management option of choice. HR would encompass 200,416 acres of marsh of different types compared with about 51,000 acres of Chenier marshes that would be subjected to MM. A reduction of tidal expression within managed areas is apparently perceived to be necessary in most cases, regardless of marsh type involved. Only a small number of projects don't amend the ambient tidal regime.

5.2.3. Coastwide

The candidate CWPPRA HM projects could subject 551,546 acres to HM (Figures Q.4. - Q.8.; Tables Q.13. - Q.17.). Up to 372,094 formerly unmanaged acres, 153,778 currently managed acres and 25,674 formerly managed acres could be involved. These acreages are corrected for potential overlaps between candidate CWPPRA HM projects, which can be substantial in portions of the Barataria and Terrebonne Basins and a large portion of the Calcasieu-Sabine Basin.

Without regard to marsh type or hydrologic regime (a trend noted relative to the historic permit data), each project specifically targets a portion of Louisiana's coastal marsh system. Marshes currently managed or targeted for management under CWPPRA typically exhibit mostly historic rather than on-going marsh losses. Generally, recorded losses were associated with man's activities and occurred mostly prior the mid-1980's. Project areas likely to continue to exhibit high loss rates or areas with the potential for accelerated losses do occur, but are not an overwhelming attribute of the candidate CWPPRA HM projects (another trend that mimics the historic permit data). Shoreline erosion is another form of historic and on-going erosion targeted, especially erosion of shorelines of larger

ponds, and more so in CWPPRA than in previously permitted MM projects. Unlike those previously permitted projects, most candidate CWPPRA projects include site-specific installation of shoreline erosion control features to combat shoreline erosion. Subsequent evaluations performed during advanced project design and NEPA compliance reviews should clarify the linkage and may reveal implementable alternative approaches for all projects.

The strategy of every candidate CWPPRA MM project and most of the candidate CWPPRA HR projects appears to be to make the targeted areas physically and hydrologically unique from the rest of the unmanaged system (another trend seen in the historic permit data). Most projects are designed to reduce the influence of the ambient hydrology within the managed area. Only a very few projects would or could achieve their management goals by not modifying the ambient hydrology. The hydrology within managed areas would be only partially reflective of the rhythm and dynamics of the hydrology in the unmanaged portion of the estuary. Differing degrees of reduced hydrologic signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to slowing marsh losses, invigorating existing marsh and expanding the amount of submerged aquatic vegetation. For some projects, intentionally inducing hydrologic differences would apparently be a separate way to add to benefits derived from arresting shoreline erosion.

Some project sites would be managed more intensively than others. The depth and duration of the flooding regimes of areas where the ambient hydrology would be modified could be operated independently of each other with the greatest potential for departure from ambient conditions in actively operated areas.

The spatial relationship between some projects in the Barataria (Basin 4) and Terrebonne Basins (Basin 5), and nearly all of the projects in the Calcasieu-Sabine Basin (Basin 9), could affect the operation of one project, or several projects could have effects on several to many other project areas. In the other basins, the likelihood of CWPPRA HR and MM projects cross-influencing each other is far less (e.g. Mermentau Basin - Basin 8) to probably none (e.g., Pontchartrain Basin - Basin 1; Teche-Vermilion Basin - Basin 7). Consequently, in basins 1, 7 an 8, effects are more likely to be specific to the project site or the very immediate vicinity.

In every case the CWPPRA-expected results of the referenced HR and MM projects are represented in terms of project-induced general differences from existing conditions but

never in terms of any specific historic condition or future condition. However, because there is no benchmark historic situation stipulated for any CWPPRA project, there is no way to precisely gauge how much marsh restoration any candidate CWPPRA HM project can be expected to achieve. Thus, to select between CWPPRA projects during CWPPRA's project evaluation process project-by-project approximations of predicted differences (based upon collective professional judgements) between the with and without management condition for each targeted marsh became the standard for comparison.

HR is clearly the management option of choice coastwide for future projects, a major departure from historic MM efforts. That trend holds true without regard for marsh type. On an acreage basis, about as much area would be encompassed by projects that encompass only one marsh type as encompass multiple marsh types. The intermediate marsh type is always included in projects that encompass more than one marsh type.

5.3. **Future With HM: Prior Permit Data Merged with CWPPRA Projects**

These summaries were derived primarily from Tables Q.18. and Q.19. and Figures Q.9. and Q.10.

5.3.1. Delta Basins

5.3.1.1. Pontchartrain

A total of 44,818 acres could be brought under management, 31,648 acres from four C/PI/I permits and 13,170 acres from three candidate CWPPRA HM projects. This represents about 4 % of the total 1,046,566 acres that could be brought under HM management.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 7,912 acres and 4,390 acres, respectively. The average size of the "future with HM" project area could be 6,403 acres.

The future project calls for the installation of new structures. Site specific construction and maintenance impacts are unavoidable.

By marsh type, only intermediate and brackish marshes would be targeted for management, the fourth and first most abundant marsh types, respectively, within the basin. Depending upon how much vegetated surface and water were actually contained within each C/PI/I project and each candidate CWPPRA HM project, how much marsh of each type

within the sub-basin was already under management, and the position/potential for interaction between projects, the 9,255 acres of marsh potentially subject to first-time management could have far greater effects than suggested by the small number of acres involved.

5.3.1.2. Breton

A total of 2,260 acres have been brought under management. There are no candidate CWPPRA HM projects proposed for this basin. Therefore, those 2,260 acres represent < 1 % of the total acres coastwide that could be brought under HM management.

The average size of C/PI/I was also 2,260 acres.

By marsh type, only brackish marshes has been targeted for management, the most abundant marsh type within the basin.

5.3.1.3. Barataria

A total of 286,239 acres could be brought under management, 225,351 acres from 13 C/PI/I permits and 60,888 acres from seven candidate CWPPRA HM projects. This represents about 27 % of the total 1,046,566 acres coastwide that could be brought under HM management. The C/PI/I projects suggest that the thrust of the effort to implement HM projects has passed in this basin.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 15,157 acres and 10,148 acres, respectively. The average size of the "future with HM" project area could be 14,312 acres.

The future projects typically call for the installation of new structures. Site-specific construction and maintenance impacts are unavoidable.

As was the case for the permitted projects, all four marsh types would be targeted for management, individually as well as in various combinations. However, the candidate CWPPRA HM projects would appear to incorporate brackish and saline marshes more so than was exhibited in the permit data.

Depending upon how much vegetated surface and water were actually contained within each C/PI/I project and each candidate CWPPRA HM project, how much marsh of each type within the sub-basin was already under management, and the position/potential for interaction between projects, the 58,340 acres of marsh potentially subject to first-time management could have far greater effects than suggested by the number of acres involved.

Interactions between projects would appear to be likely, possibly creating several interdependency situations (Plate 4). The operational schedule of some previously permitted projects may have to be modified once they come under the influence of the managed hydrology of nearby or encircling CWPPRA projects. Additionally, the position of permitted and candidate CWPPRA projects along the southern edge of Lake Salvador and eastern rim of Lake Cataouatche (Plate 4) could create a "belt" of managed spanning the distance between the Bayou Lafourche ridge to the west and natural ridge of Bayou Des Familles (a natural, historic distributary of the Mississippi River). Unimpeded communication between the upper and lower portions of the basin would be reduced to major natural and man-made waterways, possibly preserving/heightening existing differences between the upper and lower portions of the basin. Quantifying the potential for, or the form and intensity, of any such differences is beyond the scope of the PHMEIS.

5.3.1.4. Terrebonne

A total of 229,996 acres could be brought under management, 40,825 acres from 15 C/PI/I permits and 189,171 acres from 18 candidate CWPPRA HM projects. This represents about 22 % of the total 1,046,566 acres that could be brought under HM management. The candidate CWPPRA HM projects suggest that the thrust of the effort to implement HM projects has not yet occurred in this basin.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 2,722 acres and 10,510 acres, respectively. The average size of the "future with HM" project area could be 6,970 acres.

The future projects typically call for the installation of new structures. Site-specific construction and maintenance impacts are unavoidable.

As was the case for the permitted projects, all four marsh types would be targeted for management, individually as well as in various combinations. Additionally, the candidate CWPPRA HM projects would appear to continue the emphasis on intermediate and/or brackish marsh, especially in combination with the brackish marsh type.

Depending upon how much vegetated surface and water were actually contained within each C/PI/I project and each candidate CWPPRA HM project, how much marsh of each type within the sub-basin was already under management, and the position/potential for interaction between projects, the 65,539 acres of marsh potentially subject to first-time

management could have far greater effects than suggested by the number of acres involved.

The projects in this basin exhibit a complex spatial pattern (Plate 5). Installation of the Parish Line of Defense Hurricane Protection Levee along the depicted alignment would have a significant effect on the hydrology of permitted and proposed projects both Gulf-ward and landward that alignment. Landward, the potential exists to have several project areas operating independently of one another, as well as interactively influencing each other, but all subordinate to the operational schedule of the water control structures associated with the hurricane protection levee. The Gulf-ward projects would apparently be cut-off from most all upstream surface freshwater inputs. The operational schedule of some previously permitted projects may have to be modified once they come under the influence of the managed hydrology of nearby or encircling CWPPRA projects.

The management approach taken in this basin suggests a commitment to the concept that fragmenting the marsh into smaller, and presumably more "manageable," parcels, each with its own semi-natural hydrology, and reestablishing former and upgrading current management capabilities, is necessary to prolong the presence and improve the health of the marsh that remains. Quantifying the potential for, or the form and intensity of, any such commitment is a technical and engineering matter beyond the scope of the PHMEIS.

5.3.1.5. Teche-Vermilion

A total of 69,136 acres could be brought under management, 54,493 acres from 12 C/PI/I permits and 14,643 acres from the four remaining candidate CWPPRA HM projects. This represents about 7 % of the total 1,046,566 acres that could be brought under HM management. The remaining candidate CWPPRA HM projects suggest that the thrust of the effort to implement HM projects has passed.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 4,541 acres and 3,660 acres, respectively. The average size of the "future with HM" project area could be 4,321 acres.

The future projects typically call for the installation of new structures. Site-specific construction and maintenance impacts are unavoidable.

As was the case for the permitted projects, all four marsh types would be targeted for management, individually as well

as in various combinations. Additionally, the candidate CWPPRA HM projects would appear to continue the emphasis on intermediate and/or brackish, especially in combination with the brackish marsh type.

The 12,181 acres of marsh potentially subject to first-time HM management could have some incremental effects greater than suggested by the number of acres involved because of their association with existing management areas. Quantifying the potential for, or the form and intensity, of any such relationships is a technical and engineering matter beyond the scope of the PHMEIS.

5.3.1.6. Delta Region Summary

A total of 632,449 acres could be brought under management (permits = 354,577 acres; CWPPRA = 277,872 acres). Those 632,449 acres represent 60 % of the possible 1,046,566 acres coastwide that could be brought under management. The average "future with HM" project size in this region could be 8,213 acres.

Wholly new management efforts (from CWPPRA) could encompass 207,479 acres, or 76 % of the candidate CWPPRA HM efforts and 33 % of the region's potential HM effort. Implementing/sustaining valid permitted projects and, related to CWPPRA, sustaining existing management efforts (56,969 acres) or reacquiring management capabilities (13,424 acres) could account for the other 424,967 acres.

The approach in Basins 1 and 7 is to manage portions of sub-basins site-specifically. However, in at least one sub-basin of Basin 1 and in Basin 7 that approach could have basin-wide implications.

The management approaches in Basins 4 and 5 would address management site-specifically and well as at sub-basin scales such that much of several sub-basins could be brought under HM management. Clearly, a potential for large-scale implications exists, primarily as a result of the acreage and project patterning related to candidate CWPPRA projects. Appreciable potentials for project interactions and interdependencies, based on spatial patterns, were readily apparent in Basins 4 and 5 (Plates 4 and 5, respectively).

Additionally, managing smaller marsh parcels in Basins 4 and 5 is partly reflective of an initiative to reestablish former and upgrade current management capabilities. Apparently, that approach was perceived as a reasonable way to prolong the presence and improve the health of the marsh that remains. Boundaries to existing and proposed management areas would involve natural and extensive use of

existing man-made surface landscape features.

5.3.2. Chenier Basins

5.3.2.1. Mermentau

A total of 89,871 acres could be brought under management, 48,731 from 16 C/PI/I permits and 41,140 acres from the eight candidate CWPPRA HM projects. This represents about 9 % of the total 1,046,566 acres that could be brought under HM management. The remaining candidate CWPPRA HM projects suggest that the thrust of the effort to implement HM projects is occurring.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 3,046 acres and 5,143 acres, respectively. The average size of the "future with HM" project area could be 3,745 acres.

The future projects typically call for the installation of new structures. Site-specific construction and maintenance impacts are unavoidable.

In the future, all four marsh types would be targeted for management, individually as well as in various combinations. However, the candidate CWPPRA HM projects would appear to shift the emphasis slightly more towards fresh and intermediate marsh types through projects that encompass both marsh types.

The 26,759 acres of marsh encompassed by candidate CWPPRA HM projects intent upon sustaining an existing management presence or reacquiring a former management presence probably don't have spatial effects much greater than suggested by the number of acres involved. Quantifying the potential for, or the form and intensity of any hydrologic relationships is a technical and engineering matter beyond the scope of the PHMEIS.

5.3.2.2. Calcasieu-Sabine

A total of 324,246 acres could be brought under management, 91,712 from 11 C/PI/I permits and 232,534 acres from 31 candidate CWPPRA HM projects. This represents about 31 % of the total 1,046,566 acres that could be brought under HM management. The remaining candidate CWPPRA HM projects suggest that the thrust of the effort to implement HM projects is likely yet to come.

The average sizes of C/PI/I and candidate CWPPRA HM projects were 8,337 acres and 7,501 acres, respectively. The average size of the "future with HM" project area could be 7,720

acres.

The future projects typically call for the installation of new structures. Site-specific construction and maintenance impacts are unavoidable.

In the future, all four marsh types would be targeted for management, individually as well as in various combinations. However, the candidate CWPPRA HM projects overwhelming focus upon the intermediate and brackish marsh types (211,594 acres/232,534 acres = 91 %).

Project patterning in this basin is the most complex of all the basin. Nearly every marsh/pond acre of the basis would be brought under management. Marsh fragmentation, reducing the entire basin into smaller, presumably more "manageable" marsh units, to include reestablishing former and upgrading current management capabilities, was the approach perceived to be necessary to prolong the presence and improve the health of the marsh that remains. Boundaries to existing and proposed management areas would involve natural and extensive use of existing man-made surface landscape features. Nearly the entire western half of the basin would be brought under management for the first time. Some managed areas would be located within larger managed areas and/or dependent upon flows elsewhere for exchange. Therefore, the consequences of management are expected to be basin-wide and even more biologically, socially and economically intensive than the expected consequences from management in Basin 4 (Barataria) and Basin 5 (Terrebonne).

Quantifying the potential for, or the form and intensity, of the physico-chemical, biological and socioeconomic interdependencies that would arise on a basin-wide scale and possibly region-wide scale is a technical and engineering matter beyond the scope of the PHMEIS.

5.3.2.3. Chenier Region Summary

A total of 414,117 acres could be brought under management (permits = 140,443 acres; CWPPRA = 273,674 acres), or about 40 % of the acres coastwide that could be brought under management. New management could encompass 164,615 acres.

Wholly new management efforts (from CWPPRA) could encompass 164,615 acres, or 60 % of the candidate CWPPRA efforts and 40 % of the region's potential HM effort. Implementing/sustaining valid permitted projects and, related to CWPPRA, sustaining existing management efforts (96,809 acres) and reacquiring management capabilities (12,250 acres) could account for the other 249,502 acres.

The management approach in Basin 8 would be to manage portions of sub-basins site-specifically. However, in the Chenier sub-basin that approach could have basin-wide implications because of the biological and socioeconomic implications of appreciably reducing the amount of unmanaged marsh in a sub-basin where managed marsh is already the predominant condition.

The management approach in Basin 9 would be to address management at sub-basin scales through extensive use of site-specific HM (especially HR). Because much of both sub-basins are already under management and nearly all of the currently unmanaged portions of the two sub-basins could be subjected to management, the probability for potentially basin-wide implications is higher here than anywhere else in the Louisiana's coastal marshes, primarily as a result of the acreage and project patterning related to candidate CWPPRA projects.

Appreciable potentials for project interactions and interdependencies, based on spatial patterns, exist in Basin 8 (especially in the area bounded by the Gulf of Mexico to the South and Louisiana Highway 82)

The management approaches taken in Basins 8 and 9 suggest that partitioning the marsh into smaller, more "manageable" sizes, and re-establishing former and upgrading current management capabilities, are approaches perceived to be necessary to prolong the presence and improve the health of the marsh that remains throughout the region.

5.3.3. Coastwide

Either individually or collectively, historic and/or future HM initiatives represent a significant commitment of the nearly 4,500,000 acres that comprise Louisiana's coastal marsh/water complex. C/PI/I HM projects currently encompass 494,020 acres. Candidate CWPPRA MM and HR projects could encompass an additional 551,546 acres. Collectively, as much as 1,046,566 acres could be under management in the foreseeable future. The Barataria (Basin 4 - 286,239 acres), Terrebonne (Basin 5 - 229,996 acres) and Calcasieu-Sabine Basins (Basin 9 - 324,246 acres) collectively could encompass 840,481 acres. The average size of the C/PI/I projects was 6,972 acres. A future with additional HM could increase the average project size to over 7,500 acres (1,046,566 acres/138 potential HM projects). Those numbers are stunning.

Many trends observed in the historic permit data would continue. For example, the trend of including more than one marsh type would continue. Additionally, the trend of

bringing new areas under first-time management would not only continue but be accentuated, especially in Basins 4, 5 and 9, and would largely rely upon a theoretically appealing but virtually unproven option (i.e., HR), just as was the case in the 1980's with MM. A possible consequence would be to further disrupt the hydrology of some of the remaining unmanaged marshes.

Additionally, existing man-made surface landscape features have been and apparently will continue to be commonly incorporated into projects. They are often conveniently aligned along property boundaries, probably complimenting other interests, and using them rather than building new ones probably dramatically reduces project costs. Where such features don't exist or natural features are lacking, more such features would be created to facilitate project design and implementation. Thus, the average size of permitted and candidate CWPPRA projects, often their geometrical shape, and the inclusion of more than one marsh type (and certainly more than one marsh type in many of the projects in Basins 4, 5 and 7) in both permitted and candidate CWPPRA management projects is probably a reflection of these realities.

Although the extent of the future HM initiative could be extensive in the Delta basins, there does not appear to be any programmatic potential for any interactive effects between basins or any region-wide implications. Relatively speaking, that is less likely to be true for the Chenier Region, especially the portion of the Calcasieu-Sabine Basin associated with the Calcasieu River estuary. Given the extent of historic and proposed HM in that coastal river estuary, the potential for physico-chemical, biological and socioeconomic effects beyond the upstream limit of the study area should not be ignored.

The biological and socioeconomic effects of MM and HR historically and into the future are not categorically definable by any particular project location, project purpose, structure type(s) or operational plan(s) or even any combination.

Whether successful or not, the acreage that could be committed to HM in the future could encompass nearly 25 % of today's coastal area. If successful, that same area could contain a significant amount of the remaining emergent vegetation on native, uneroded soils, as well as vegetation on exposable eroded soils, by the year 2015, especially in the Delta Region. But that would likely come at the cost of prolonging or even aggravating, rather than solving, several issues rooted in socioeconomics.

The degree of success or failure attained in any given area probably can't be accurately gauged without monitoring. Performance criteria as part of the monitoring protocol could serve as a benchmark for gauging success.

Projects undertaken pursuant to CWPPRA represent a much lower risk of monitoring non-compliance because of CWPPRA's requirement for monitoring and associated funding provision for monitoring. However, monitoring required pursuant to CWPPRA, and monitoring that may be deemed appropriate pursuant to a permit issuance, need not be identical. That discontinuity could well be a source of discord manifested as selective or outright non-compliance with monitoring provisions that are in excess of what CWPPRA would fund.

The degree of success or failure, and the associated socioeconomic implications, will probably dictate whether management would be discontinued or intensified as the individual and combined effects of subsidence, wind-driven wave-induced erosion and sea-level rise continue to claim more marsh acres within managed as well as unmanaged marshes.

For AMM, the record evidences an interdependency between meteorological variations and hydrology, and other significant attributes as well, on several temporal and spatial scales. Those interdependencies apparently have aided AMM efforts about as often as they have been hindered or negated prior management successes. Accordingly, AMM could easily be regarded as too susceptible to short-term and seasonally intense meteorologic events alone to be characterized as a repetitively and predictably effective approach to reversing or stopping marsh losses in the long-term, or even site-specifically, in the short-term.

However, the MM record also demonstrates that AMM could be considered a predominantly short-term, site-specifically effective way of periodically expanding the amount of marsh vegetation on native and exposable soils (apparent marsh gain) and/or submerged aquatic vegetation within areas targeted for management.

HR, especially in cases when it attempts to emulate a natural, historic hydrology, is an as yet untested and undocumented but theoretically appealing, recently-evolved form of MM. Early applications will be learning experiences, just as it was when wildlife managers brought their specialized but untested skills and insights to bear on the marsh loss problem. Determining what controls how far back in time hydrologies can be successfully emulated should itself prove to be insightful. But like any new, untested endeavor, it will take time to understand, will

have a high learning component, will require adjustments, and will also require subjecting marsh to unforeseen risks. Monitoring is a site-specific way to gather information.

Nonetheless, HR would seem to be perceived to have wide applicability coastwide. In excess of 200,000 acres would be committed to HR (in its passive form), much of which would be in the western-half of the Calcasieu-Sabine Basin. HR would also be the management option of choice for re-establishing former or upgrading existing active management efforts, some of which were/are MM projects.

Also, recall that candidate CWPPRA HM projects need not be pursued solely under the auspices of CWPPRA. That brings into questions the potential for partially implemented projects.

Finally, project designs and positioning one-to-another would accentuate existing and/or create new hydrologic interdependencies. Where those interdependencies are part of a larger effort and managed areas owned by several different people (for example in Basin 9), maintaining the operation of the projects in the required spatial and hydrologic relationships becomes a consideration with added biological, socioeconomic and regulatory implications.

With or without any follow-up now or in the future, incompletely implemented projects could be assumed to involve additional site-specific effects previously unaccounted for. Some effects may be detrimental, possibly destructive (some may be irreversible if dredging marsh is involved) to some significant biological attributes. The landowner(s)/leaseholder(s) of these targeted marshes appear to be the most obvious and immediate recipients of any socioeconomic effects that may have arisen from partial implementation.

Project-derived benefits are expected to continue to fall short of expectations, but not as often or as extensively as has been the case in the past. Incomplete project implementation should be much less of a factor in the future because of the planning and funding commitment associated with projects installed and operated pursuant to CWPPRA. And, it is not unreasonable to assume that some regulatory efforts may be determined to be necessary to address projects that were only incompletely installed. Additionally, an in-depth examination of the socioeconomics of HM would seem to be fertile ground if predicting outcomes to permitted projects and/or formulating more insightful permit conditions were determined to be necessary.

5.4. Future Without (No Action) and Future With Additional HM: Significant Physico-chemical Attributes

Every HM project, whether historic MM or a candidate CWPPRA HM project, unavoidably causes a chain reaction between many physico-chemical attributes. This is true whether a project is partially or completely implemented.

The trend of partitioning marshes into subordinate, often interdependent, hydrological units, each with its own semi-natural hydrology, is expected to continue. As evident in the permit data, the trend is independent of who a permittee was, what the stipulated project purpose(s) were, and what the history of land loss or included marsh type(s) was. Differences between passive and active management would be a matter of degree. In passively managed areas, reduction of the rhythm and dynamics of the tidal message would tend to be what was designed or allowed to occur through unobstructed, often natural, waterways or structures, or occurred over structures when tides rose to levels that overtopped them or the marsh. In the most actively managed areas, more intensive, largely seasonal interruptions could occur/should also be expected.

Some of the most influential physico-chemical attributes of marshes are related to hydrology.

Regardless of how well informed architects of HM projects may be, the unpredictability of meteorological events can aid just as often as frustrate managers' efforts to reduce water levels/salinity on a predictable basis. The effects of more acute meteorological events (e.g., tropical weather systems, prolonged periods of inadequate rainfall) are uncontrollable and unpredictable in their frequency, intensity and duration and overwhelm the design parameters of nearly every HM project. Accordingly, managers often must undertake actions to mute, minimize, offset or reverse the counterproductive effects of such events through their ability to regain and exert control over the hydrology of managed marshes.

5.4.1. Hydrology

5.4.1.1. Hydrology (Water, Sediment and Salinity)

5.4.1.1.1. Future Without Additional HM

Many marshes subjected to fully implemented and properly operated HM (AMM and/or PMM) projects can be expected to exhibit some measurable differences from unmanaged marshes. None of the potential effects is supported by irrefutable evidence or highly predictable.

Recalling the relationship between sediments, nutrients and aquatic plant growth, the early evidence suggests that actively managed semi-impounded areas have significantly different short-term and apparently different long-term sediment budgets than do unmanaged areas. HR is virtually unstudied in this regard. Thus, a definitive answer probably has to wait until the sediment and nutrient dynamics and plant responses are better documented.

In fully installed and operable management areas, the predictable effects on water levels and salinity can range from being partially suppressed (typically PMM) to being totally out of synchrony with the rhythm and dynamics of the surrounding unmanaged marshes (as can happen for prolonged periods in areas subject to AMM). At the current level of sophistication, achieving a design water level reduction within any managed area on a predictable basis appears to be a hit or miss proposition governed largely by meteorological conditions. The same appears to be true regarding salinity level manipulations unless their is a predictable fresh water source and a means to regulate inputs to affect adequate dilutions (e.g., a pump).

Regardless of the management form (AMM, PMM), sediment budgets of fully installed and operable managed areas are unavoidably affected. Restrictions on sediment delivery and mobility both appear to follow this general relationship: AMM≥PMM>unmanaged. Sediment retention relationships are less easily represented because of the confounding effects of repeated attempts to reduce water levels in marshes subjected to AMM and what appears to be a greater dependence upon storms to replenish sediment delivery shortfalls in marshes subjected to AMM. Accordingly, fully operable AMM areas may have the greatest potential to heighten the production of organic sediment matter but whether the difference can quantitatively offset or functionally replace unavoidable reductions of mineral and organic sediment inputs from outside the managed area matter has yet to be conclusively demonstrated. What's more, AMM areas may only be inconsequentially more efficient at retaining sediments, especially when water level reductions are attempted. Finally, the implications are greater for mineral-sediment dependent marshes, which also are generally the more saline marsh types. It is also these mineral sediment dependent marshes that have been targeted more often for management. Consequently, if the effects are truly inconsequential, then the bulk of the managed marshes should be benefitted. However, the currently available information suggests that at least for areas subjected to AMM the result falls short of being a quantitative or even a qualitative trade off in the long-term.

To slow losses, increased and retained production of organic matter from all sources must offset and be a functionally equivalent substitute for an appreciable amount of any sediment (mineral and/or organic) deficiencies. To forestall or stop marsh losses, increased and retained production from all sources must at least equal and be a functionally equivalent substitute for any sediment (mineral and/or organic) deficiencies. To reverse marsh losses increased production and retention from all sources must exceed the export and decomposition process rates and be a functionally equivalent substitute for any sediment (mineral and/or organic) deficiencies.

Convincing documentation of such management induced situations predictably occurring in Louisiana situations is lacking. Any such HM efforts could be viewed as experimental demonstrations.

Improved retention of organic matter regardless of the source would seem to be required to optimize the potential to rebuild lost marsh soils in sediment poor situations (actual marsh gain).

In marsh areas associated with incompletely installed projects, the situation is virtually unquantified. Lacking data, only an approximation of the potential range of effects is possible....from negligible to quantitatively quite different, depending upon what structures were used, their current condition and configuration and how complete the project was when work stopped. It's quite likely that sediment redirections have occurred, at least locally. Whether a balance has been struck between areas gaining and areas deprived of some sediment would require an examination of each situation. As for water velocities and water levels, again the nature of the effects would appear to be highly localized.

5.4.1.1.2. Future with Additional HM

HR is a form of HM with no track record. Conceptually, however, it's relationship to the other forms of HM and unmanaged marsh relative to its restrictive effects on hydrology should be approximated by the following relationship: (AMM≥HR≥PMM)>unmanaged marsh. Local conditions and specific project designs and operational schedules should be examined to determine more precisely where any particular project can be located.

5.4.2. Subsurface Geology/Sea Level Rise and Surface Geomorphology

An examination of Plate 8, entitled "Marsh Management

Feasibility," from Cahoon and Groat (1990) revealed that an extremely high proportion of the soils in the south-central portion of the Terrebonne Basin exhibit some of the highest rates of subsidence in the coastal zone. Relative sea level rise is also high. This area is also underlain by soil that structurally may be poorly suited to support water control structures and levees. In the Chenier Basins, the situation does not appear to be as critical.

5.4.2.1. Future Without Additional HM

The collection of C/PI/I and candidate CWPPRA HM projects typically call for the installation of new and/or rehabilitation of existing surface water control features. These generally include levees and water control structures positioned at strategic locations along project boundaries. Local subsidence rates and rates of sea level rise will remain counterproductive forces to historic management efforts. Many managers can be expected to react by requesting/attempting ever more aggressive water level control efforts in the future.

Any such effort could be most pronounced for the C/PI/I HM projects located in the area roughly bounded by the arc defined by the eastern-most part of Fourleague Bay, a point several miles south of Houma and the line bounding Timbalier and Terrebonne Bays, may be predisposed to higher potentials expectations falling short of realized results as well as higher costs to install and maintain projects.

5.4.2.2. Future With Additional HM

See immediately above.

5.4.3. Marsh Ponds/Open Water Areas and Marsh and Pond Soils

An examination of Plate 8, entitled "Marsh Management Feasibility," from Cahoon and Groat (1990) revealed that an extremely high proportion of the soils that comprise the delta basins may be poorly suited for the installation of water control structures and levees. Most if not all of the C/PI/I and CWWPRA projects in the Delta basins must contend with that possible constraint. The exceptions are projects in the Middle Sub-basin of the Pontchartrain Basin and projects along the western rim of Vermilion Bay in the Teche-Vermilion Basin.

In the Chenier Basins, the situation is not as critical.

5.4.3.1. Future Without Additional HM

In general, achieving the desired results in Delta Basin marshes would seem to entail greater maintenance efforts, especially during the later phases of projects. Without any such efforts, there appears to be a higher potential for diminishing returns, or even a few premature project failures, during the later stages of projects in the Delta marshes than in the Chenier marshes.

5.4.3.2. Future With Additional HM

See above

5.4.4. Water Temperature, Dissolved Oxygen and Nutrients

HM efforts unquestionably have the potential to have short-term impacts on the structure and function of managed Louisiana marshes. Boumans and Day (1990) reported on the short-term effects of an AMM effort on the forcing mechanisms and dynamics between managed and unmanaged marsh pairs. They noted measurable differences between managed and unmanaged marshes.

The effect of water control structures on the ambient hydrology was clearly the key. Thus, that aspect of each project should be understood to forecast the ultimate form and magnitude of the effect any form of HM might have on a particular targeted marsh.

Studies in South Carolina (McKellar 1986) also revealed several measurable differences between managed and unmanaged areas, not altogether different from what was observed in Louisiana by Boumans and Day (1990). Managed South Carolina impoundments tended to exhibit seasonal differences, reflective of reduced summer-time exchanges which is in contrast to maximal exchanges in unmanaged marshes at the same time, and an enhanced role of phytoplankton in nitrogen dynamics. McKeller (1986, page 127) commented, "....As long as a wetland is dominated by submerged benthic communities (as in impoundments), there will be considerable differences in the ways that system processes nutrients compared to an intertidal system....Further research is clearly needed to effectively address the issues concerning the impact of impoundments on estuarine water quality and productivity."

5.4.4.1. Future Without Additional HM

Provided the designed hydrologic controls can be achieved, differences between managed an unmanaged areas should be expected. But, it remains to be determined to what degree differences reflect the effects of management, prevailing

weather patterns, site-specific peculiarities, or some combination thereof.

5.4.4.2. Future With Additional HM

Provided the desired hydrologic controls can be achieved and sustained, AMM project areas, being the most restrictive on hydrology, should induce the greatest degree of difference.

HR, in situations that don't mimic former AMM efforts, have the potential to be less impact intensive, but care should be given to the project's effects on smaller-scale hydrologic differences, especially in projects that encompass several thousand acres and large open water areas.

Adverse effects on these significant attributes (eg, diminished nutrient inputs) may be reduced only to the point that any such efforts don't compromise the overall purpose(s) and goal(s) of the project.

5.4.5. Cumulative Implications

Complete or even partially documented reports characterizing how these significant resources, especially nutrients, responded to management are too few in number to be considered representative.

5.4.5.1. Delta Basins/Region

In Delta Basins 4 (Barataria), and 7 (Teche-Vermilion) interactive effects between projects are possible/probable but do not represent the majority condition. Exchange between some adjacent project areas can be/does range from diminished to eliminated.

5.4.5.2. Chenier Basins/Region

The probability of interactive effects between individual project areas is extraordinarily higher in Basin 9 than in Basin 8, or anywhere else.

The hydrologic rhythm and dynamics of as much as 151,544 acres of previously unmanaged marsh in Basin 9 could be disassociated from the rhythm and dynamics of the estuary. Because of the spatial arrangement of many of those projects, the probability of interactive effects is higher in this basin than anywhere else.

No where else within Louisiana's coastal marshes has man intentionally contemplated directly controlling the hydrology of up to 250,000+ contiguous marsh acres, which is nearly all the marshes that comprise Basin 9. If

implemented, man will have intentionally assumed primary responsibility for sustaining and/or tightening control of the hydrology over marshes currently managed (100,000+ acres) or providing for establishing the first-time direct control of the hydrology over an even larger area (150,000+ acres) under the premise that a managed marsh is better than an unmanaged marsh.

The potential HM effort in Basin 9 could be considered an irreversible commitment of resources. Because nearly the entire basin's marsh complex would be partitioned into subordinate, interdependent project areas, the situation in Basin 9 is unique. Many projects do or would share common boundaries, water control structures and/or waterways. Some projects are/would be wholly contained within the boundaries of other projects while the hydrology of others is/would be dependent upon inputs from adjoining areas. Each project's structures would have to be maintained by each permittee. Each project's structures would have to be operated in a manner that reflected the hydrologic interdependencies that would be created. What's more, as properties change hands, changes in purpose that would dictate structural and operational revisions would have to be considered relative to interactive effects on interdependent projects. Monitoring should be designed to reflect individual project performance as well as basin wide performance. A level of coordination and oversight not previously encountered may be required. Finally, once installed, removal of structures is unlikely to occur if for no other reason that it would cost money that isn't available. And the expenditure of additional public monies to undo any number of publically-funded projects does not have apparent public appeal. And permittees have resisted the inclusion of permit conditions identifying them as the entity responsible for the removal of structures should the need arise.

5.4.5.3. Coastwide

Clearly, the inability to definitively characterize effects for individual projects is a major and pervasive obstacle to precisely forecasting and quantifying cumulative effects coastwide. It reduces impact/effect forecasting to a predominantly qualitative exercise, the results of which will unquestionably be the subject of discussion.

The volumes and rates of inflows, through flows and outflows of water, sediments and/or salinity have been amended locally within project areas. That may well be true for areas in close proximity to but outside managed areas. The extent of any such effects has not been documented. A potential consequence is that down stream marshes as well as projects become more susceptible to the forces of the Gulf

as upstream influences are intercepted resulting in a downstream reduction/elimination, at least on a local scale. This situation is probably most important to consider where marsh types are trending towards or have recently changed to saltier marsh types.

The effects of generally imprecise/inadequate information about the existing hydrology at and within the vicinity of HR project sites may not be as great a shortcoming for projects designed to mimic a preexisting, natural hydrology. Information about prior patterns can be fairly easily reconstructed from existing records and experiences. Whether effects are similar or identical remains to confirmed.

The trend of partitioning marsh systems into smaller, more individually manageable parcels is likely to continue. Thus, the potential to create new hydrologic interactions and/or interdependencies between projects is appreciably more likely in some basins than others.

There does not appear to be any potential to affect any existing or to create any new interbasin inter-actions/interdependencies. In that sense, the effects to these significant attributes, especially in the future with additional HM, seem to be scaled to individual project sites but have a very real potential to effect portions of (Basin 4) or entire basins (Basin 5 and 9).

To the applicant/non-permit analyst the significance of any differences is apparently in the eye of the beholder, and is typically scaled in terms of their impressions and value judgements of what a project's effect(s) will possibly be on a few socioeconomic attributes.

5.5. Futures Without (No Action) and With Additional HM: Significant Biological Attributes

5.5.1. Primary Production

5.5.1.1. Historic and Future Without Additional HM (No Action)

Phytoplankton, marsh micro-organisms, emergent vegetation on native and exposable soils and aquatic vegetation have been unavoidably affected by management, sometimes intentionally and sometimes not. Emergent vegetation and aquatic vegetation have been the historically targeted attributes.

Expanding the extent of aquatic vegetation appears to be the most predictable response (intended or not) to most HM efforts. If water level stabilizations/reductions are

attempted and succeed, production from invigorated emergent vegetation on native soils could increase in the short-term. Additionally, any vegetation induced to grow on exposable soils will also contribute to overall primary production. However, uninterrupted and continuous long-term control over water levels is most conducive to yielding long-term results.

For emergent vegetation, especially on exposable soils, management successes appear to be largely dependent upon the managers's ability to configure water control structures to take advantage of favorable meteorological and hydrologic conditions and to reduce/mute/override counterproductive meteorological and hydrologic conditions (Cowan et al. 1989). Uninterrupted and continuous long-term control over water levels appears to be nearly essential if heightened productivity from this significant attribute is to be sustained.

Christian et al. (1978), working in an unmanaged, free-flowing Georgia salt marsh, reported that the soil microbial community was resistant to change because their life process were relatively unlinked to plant growth. Either the slow decay of retained organic matter served as a buffering slow-release nutrient source or these organisms were controlled by physico-chemical factors. In 1986 Kelley, McKellar and Zingmark (1986) looked at microorganisms in managed and unmanaged South Carolina marshes. They reported the responses to water level management were unavoidable, reciprocal and compensatory shifts in numbers, biomass and probably species assemblages. Apparently, similar studies have not yet been reported in the general literature for managed Louisiana marshes. The Georgian and South Carolina studies could serve as model for Louisiana.

Phytoplankton are unavoidably affected by HM, and significantly so adversely during extended water level reductions. The implications of those affects can only be framed relative to the response of the soil types included in the managed area, how management affects water chemistry, water temperatures and hydrology. Although these apparently remain to be described in managed Louisiana marshes, a possible reaction would be that which has been reported from Kelley, McKellar and Zingmark (1986) from a managed South Carolina impoundment....unavoidable, reciprocal and compensatory shifts in numbers, biomass and probably species assemblages.

In summary, in many but not all instances, HM efforts can be expected to succeed at inducing differences between managed and unmanaged areas. Those differences appear to be degrees of unavoidable reciprocal, apparently compensatory shifts

between the contributing significant attributes. The degree to which managed areas can be differentiated from one another and the rhythms and dynamics of surrounding marsh systems appear to dictate the ability of managers to sustain induced differences.

5.5.1.2. Future With Additional HM

Phyto-plankton, marsh micro-organisms, emergent vegetation on native and exposable soils and aquatic vegetation will continue to be unavoidably affected by management.

Unavoidable effects on phyto-plankton and marsh micro-organisms apparently have been unintended and their role in the functioning of managed marshes are largely unappreciated. That trend is likely to continue.

5.5.1.5. Primary Production: Cumulative Implications

Rather than a goal unto itself, increasing primary production is a means to an end. Historically, expanding and/or invigorating aquatic vegetation was principally undertaken to improve waterfowl habitat. And, areas subjected to HM probably will tend to exhibit more extensive stands of aquatic vegetation than many unmanaged areas.

More recently, HM was and apparently will be undertaken to forestall, slow, stop or reverse marsh loss. Heightening primary production and retention of organic matter is perceived as, and as a result is often undertaken as, necessary in sediment deficient marshes.

HM efforts that involve some degree of water level control to affect primary production in managed areas can be regarded as a site-specific strategy with an unspecifiable performance potential. Over the short-term, apparent marsh gains can probably be achieved on a predictable, recurring basis about half the time. However, stopping or reversing marsh losses through greater primary production will probably remain an appealing, but largely theoretical and unproven, approach.

The biomass of plant material from emergent and aquatic vegetation can be increased in some instances, but not with any apparent degree of consistency or predictability because of the dependency on successful gravity-dependent water level reductions. That hints that the applicability of the endeavor may have different implications between areas subjected to MM versus some forms of HR. In areas subjected to MM, and some forms of HR, retention of additional material may not be as great as desired (Bouman and Day 1990). The application of a pump (Lehto and Murphy 1989)

improves the predictability of results, and may have applications in marginal situations.

Trying to draw conclusive insights about or predicting the response of primary productivity to HM efforts in Louisiana marshes remains largely a matter of professional insight, in which case the insight from managed and unmanaged South Carolina marshes are insightful and can serve as a model.

What can be concluded, however, is that even if enhanced production of macrophytes (i.e., submerged aquatic plants, emergent marsh plant species) in managed Louisiana marshes does occur, it may not be conclusive evidence that overall primary production increases correspondingly, or that marsh losses can be affected in the long-term (especially Delta marshes). Apparent marsh gains can be achieved to some unknown degree by enhancing the production of emergent vegetation (on native and exposable eroded soils) and aquatic vegetation in some management situations.

Past and future research, reports and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree, if any, attempts to invigorate components that contribute to primary production contributes to forestalling marsh losses

The results of several years of designed experimentations by the US Fish and Wildlife Service and other researchers should prove very insightful. Those study results may also diminish the need for any equally intensive studies in the immediate future.

5.5.2. Higher Levels of Production

5.5.2.1. Zooplankton

5.5.2.1.1. Historic and Future Without Additional HM (No Action)

Many zooplanktors are in all likelihood unintentionally affected by HM efforts.

In Louisiana, studies of shrimp and other forms are insightful and studies from South Carolina are also illuminating.

Apparently, population compositions and standing crop densities, depending upon species, in managed South Carolina ponds can be statistically similar to and occasionally significantly higher than what occurs in unmanaged tidal

creeks (Taniguchi 1986). Additionally, he observed that within several weeks zooplankton population densities returned to prewater level drawdown densities. He concluded that management of ponds does not separate planktonic fish larvae and their food and that differences between managed ponds and unmanaged marshes tended to be short-term.

Monitoring didn't encompass this significant attribute.

It remains to be determined to what degree differences between managed and unmanaged areas may be site-specific, and whether differences between management options, are categorical, site-specific, or some combination of both.

5.5.2.1.2. Future With Additional HM

An area ripe for further academic study.

5.5.2.2. Benthos

5.5.2.2.1. Historic and Future Without Additional HM (No Action)

Louisiana marshes subjected to HM can be expected to exhibit measurable compensatory relationships between each other and unmanaged areas for this significant attribute.

Juvenile planktonic forms can be expected to appear at the unmanaged side of water control structures reflective of life history patterns. However, water management schedules appear to be able to impart an unintended access bias advantageous more so to spring migrants and disadvantageous to later season migrants. Structures and management regimes imposed access and retention selectivities of the commercially and recreationally important blue crabs and Penaeus shrimp.

5.5.2.2.2. Future With Additional HM

The effects of HM would appear to be potentially more intensive in large portions of the lower Barataria Basin and Timbalier Sub-basin of the Terrebonne Basin as the combination of future marsh losses and potentially more managed acres greatly accentuate the access and retention biases, despite the apparent liberal use of rock weirs. Much the same effect could arise in the Mermentau and especially the Calcasieu-Sabine Basins of the Chenier Plain. In the Chenier Plain Basins the effect is seen to be more a function of expanding HM efforts than future marsh losses.

5.5.2.3. Fish

Despite the cultural implications and socioeconomic overtones of fisheries, never has the improvement of fisheries habitat been the single or even a stipulated purpose for any HM effort submitted for permit consideration. However, proponents of HM have credited management with indirectly improving the quality of and/or prolonging the existence of fishery habitat in managed areas.

5.5.2.3.1. Historic and Future Without Additional HM (No Action)

This significant attribute probably has been, is and likely will continue to be affected relative to efforts undertaken to achieve other biological management objectives (e.g., waterfowl habitat improvement, addressing marsh loss).

There is no time during the year when fish (recreationally and/or commercially important or not) are absent from Louisiana's costal marshes. Generally speaking and regardless of their design, water control structures used in HM efforts function as physical as well as behavioral impedances to movement patterns for many speceis. Those same structures also are responsible for creating differences in the water chemistries between managed and unmanaged areas that give rise to the potential for different fish communities to occur on either side of the structures. Those differences appear to be degrees of unavoidable, reciprocal, apparently compensatory shifts generally towards more fresher fish communities inside managed areas. The degree to which the fish component of managed areas can be differentiated from one another and surrounding marsh systems appear to refelct the ability of managers to sustain induced differences.

The actual form and degree of any differences depends upon the marsh type involved, the fish species, the structure used and its operation. More study could focus on discerning what the precise quantitative relationships are between the several kinds of water control structures and the forms of HM.

Whenever organisms encounter water control structures, they must contend with an obstacle. At that point in time and space, that structure poses the same obstacle to those organisms whether or not the structures are part of a MM plan or a HR plan and whether or not the organism is coming or going. The difference is one of numbers....can those organisms, or others of its kind, access or exit the managed areas at the site or via other routes in sufficient numbers.

Efforts to reduce or minimize adverse impacts to migratory, estuarine species have been undertaken, but in many cases only in so far as they don't compromise the principal objective(s) of HM efforts. Additionally, as fresher marshes yield to saltier conditions, the some fresher fish communities that can become associated with some managed areas have often been represented as restored resources.

5.5.2.3.2. Future With Additional HM

The expansion of HM programs would have site specific effects of fisheries movement patterns and access/exit patterns. And those effects could also be proportionally more intensive cumulatively as more and more acres are brought under management, especially in portions of the Terrebonne and Barataria basins as well as much of the Mermentau, and especially the Calcasieu-Sabine Basin (especially the marshes between the study area and Lake Charles and the marshes associated with the Sabine Lake system. In the Calcasieu-Sabine Basin the future trend is to bring HM to portions of the remaining managed and unmanaged marsh by creating smaller, interdependent management efforts.

The overall effects of management remain to determined. All of the studies to date can only be used to infer what the possible response might be to HM projects. However, management projects (e.g., most HR projects) that do not consist of semi-impoundment and/or involve water level controls that eliminate tidal waters from flowing over the marsh surface and/or entail water level reductions that result in withdrawing the water's edge from the marsh edge, probably have less adverse impacts to fisheries resources. Additionally, any fishery species that is confined to a managed areas and cannot complete its entire life cycle within the managed area will be unavoidably impacted adversely. In this regard, perhaps Montague, Zale and Percival (1987, page 751) captured the essence of the relationship between managed marshes and fishery resources:

> *"Estuarine organisms that benefit most from the perhaps equal or greater nutrition present in managed impounded marshes are those that can enter the impoundment and survive there while feeding. The most significant question concerning the effect of impoundment on production of estuarine fish and shellfish is not whether the net transport of bulk organic matter and plant nutrients is altered, but rather whether estuarine fish and shellfish can enter, grow, and leave impounded marshes in a way that is compatible with estuarine fish management objectives."*

The response of fisheries to structures seems to be linked to the structure's impact on hydrology. Some socioeconomic impacts (e.g., access, property rights) occur more or less independent of the management structure impact on hydrology.

5.5.2.4. Wildlife: Reptiles and Amphibians

5.5.2.4.1. Historic and Future Without Additional HM (No Action)

Favorable effects of HM efforts on the population status of these species are often cited as an unintended but indirect consequence of management efforts undertaken to control marsh losses or further other biologic and/or socioeconomic interests.

Reptiles and amphibians as a group, but especially those in managed fresh and intermediate marsh undergoing or under the eminent threat of salt water intrusion, have been, are and are expected to be unintended but indirect beneficiaries of management efforts. The American alligator is often cited as an intended but indirect beneficiary of HM efforts.

HM efforts that entail seasonally (e.g., springtime - nesting season) stabilizing flooding depth and duration as well as water chemistry (e.g., general salinity reductions) coincidentally tend to improve habitat conditions for the American alligator, a speceis of socioeconomic interest.

5.5.2.4.2. Future With Additional HM

HM that successfully controls salinity would be expected to expand benefits to this speceis group.

5.5.2.5. Wildlife: Birds

5.5.2.5.1. Historic and Future Without Additional HM (No Action)

The life requisite requirements of this wildlife group encompass all the marsh types that comprise coastal Louisiana. Therefore, regardless of where or what kind of marsh is targeted, this group will be effected.

Collectively, this wildlife group (exclusive of waterfowl) is impacted unintentionally. And, differences resulting form management appear to be degrees of unavoidable reciprocal, apparently compensatory shifts. A mixture of managed marsh types and management options would appear to maximize overall benefits and minimize overall adverse effects.
Coordination with the FWS and LaWLF has succeed in reducing

or eliminating adverse effects to rookeries and other communally nesting birds.

5.5.2.5.2. Future With Additional HM

If HM efforts succeed at slowing future marsh losses, the overall effect will probably prove to be positive for the wading and shorebirds of this species group. However, the emphasis on HR could have detrimental effects on some species that derive life requisite resources from periodically exposed surfaces or if a variety of water levels over marsh substrates are not available as foraging habitat for several migratory species.

Coordination with the FWS and LaWLF will continue.

5.5.2.6. Wildlife: Mammals

5.5.2.6.1. Historic and Future Without Additional HM (No Action)

Nearly all the species are well represented in terrestrial habitats. Most excursion into the marsh opportunistically. Nearly all can be thought of as unintended but indirect beneficiaries of management and past actions of man. Only the furbearers are intended, direct beneficiaries of management. Some aspects of intentionally enhancing their habitat conditions adversely affects some species, beneficially affects others and may have little or no effect on the local species population of others.

5.5.2.6.2. Future With Additional HM

See above.

5.5.2.7. Wildlife: Furbearers

5.5.2.7.1. Historic and Future Without Additional HM (No Action)

Management targeting nutria (more so in fresher marshes) and/or muskrat has declined during the last decade. This species group has been unavoidably impacted by and influenced management practices in coastal Louisiana.

Nutria and muskrat have been intended (but seldom specifically targeted) indirect beneficiaries of management.

Stabilized water levels during the winter are conducive to marsh burning, which is undertaken to stimulate the growth and/or improve the coverage of a few marsh grass species (especially Olney's three-corner grass) for muskrats and to

improve access to marshes by fur trappers. The other furbearing species are apparently unintended but indirect beneficiaries of management and past actions of man.

Changing social perceptions about furs has translated into a long-term decline in fur prices.

5.5.2.7.2. Future With Additional HM

The decline in furbearer-driven management efforts, even as a secondary reason to manage, is likely to continue, especially regarding the nutria.

An expansion of HM would probably result in generally improved conditions for furbearers. However, grazing on marsh vegetation has been recently cited as a factor adversely influencing the primary productivity of the marsh as nutria are more and more suspected of accentuating marsh losses (Taylor and Grace 1992; Taylor et al. 1992; Conner 1992; Foote and Johnson 1992; Linscombe 1993; Llewellyn and Shaffer 1993; Nyman, Chabreck and N. W. Kinler 1993a). Nutria can denude areas (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor et al. 1992), exposing the fragile marsh surface to erosive forces. Nutria burrows can undermine an area so thoroughly that the marsh surface caves in and washes away (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor et al. 1992). Thus, improved conditions for these species may not always be compatible with maximally addressing historic, on-going or future marsh losses, unless a sustained population control effort is maintained to locally control muskrat and nutria numbers.

5.5.2.8. Wildlife: Waterfowl

5.5.2.8.1. Historic and Future Without Additional HM (No Action)

Improving the condition of the habitat for overwintering migratory waterfowl have been a reason to conduct HM efforts.

When targeted for management, they benefit indirectly in response to intentional manipulations of selected physico-chemical significant attributes. For the same reason, waterfowl could be indirect beneficiaries of HM efforts that focus on forestalling, slowing, stopping or reversing marsh loss.

The readily retrievable literature is fairly extensive and convincing in reporting the observed responses of life requisite resources (e.g., aquatic vegetation) to management. A corresponding response by waterfowl is

typically inferred (if managed the ducks will respond) but generally unquantified. However, relative to the response of waterfowl, the readily retrievable literature is conspicuously lacking in studies that have predicted/correlated/measured: 1) differences between hydrologically managed and unmanaged areas in Louisiana (other than refuges); and 2) the magnitude of incremental differences between marshes managed for waterfowl and marshes managed to address marsh losses. And, the permit monitoring data base is of no help in this regard. Thus, the debate about what the various forms of HM can or can't be expected to predictably and repeatedly accomplish relative to waterfowl and what the consequences are to other impacted significant attributes in any given situation is likely to continue and be subject to professional judgement.

5.5.2.8.2. Future With Additional HM

An expansion of HM will probably result in an expansion of improved overwintering conditions for migratory waterfowl.

It appears that waterfowl will be reduced to the role of indirect beneficiaries of HM efforts but will continue to be a resource of primary management interest. However, related recreational and commercial implications will probably continue to be influenced more by breeding success and bag limits.

5.5.2.9. Cumulative Considerations: Higher Levels of Production

Hydrologic management of marshes attempts to create and maintain discontinuities between managed and unmanaged areas. Selectively and differentially controlling several hydrologically-influenced attribute(s) of a marsh is typically required to set in motion a chain of events leading to the desired management outcome. Outcomes typically focus on selected biological and socioeconomic marsh-dependent attributes.

Improving habitat conditions for targeted marsh-dependent animal species was historically the single most important reason to conduct HM, driven by the socioeconomics of the targeted marsh-dependent species.

During the last 10 years, addressing marsh losses has emerged as the foremost stipulated reason to pursue HM of Louisiana's coastal marshes.

It appears that management that will focus on more optimally managing for prolonging or invigorating marsh grasses will promote a broader base of support for a broader range of

species rather than target a limited number of marsh-dependent animal resources of socioeconomic interest. Apparently, several aquatic, estuarine-dependent species would be unavoidably effected. Impact reductions are possible but cannot be totally avoided. The magnitude and location of those biological effects are likely to have at least local socioeconomic implications.

5.5.3. Marine Mammals and Threatened And Endangered Species

See also Appendix P.

The following discussion is programmatic in its scope. It does not relieve the NOD of its obligations to conduct all necessary reviews and coordinations on any project.

5.5.3.1. Fish

Gulf sturgeon have evolved within Gulf coast drainages exhibiting seasonal patterns of high and low flows, temperature regimes, sedimentation and other physical factors. Historic and candidate CWPPRA HM efforts do not include riverine habitats such as is frequented by this species. Hence, programmatic potential impacts of HM efforts on the Gulf sturgeon are considered minimal.

5.5.3.2. Reptiles

The LA-STSSN data (1990-1994) shows that of the reported 373 turtles stranded in Louisiana, approximately 60 percent were in Cameron Parish and 26 percent were in Jefferson Parish. Strandings in Lafourche Parish were somewhat frequent (eight percent), but the number of strandings in Terrebonne Parish was low (one percent). It should be noted that because of differences in beach access and coastline irregularities, reports are likely to reflect these influences.

Recent research has shown that sea turtles are virtually absent from the nearshore waters of the northern Gulf from December through March (Renaud et al. 1995) and except for the Kemp's Ridley turtle seldom if ever would be directly impacted by HM activities. Kemp's ridley sea turtles may be found in Louisiana coastal waters during the summer where they forage for food (to include crabs).

5.5.3.3. Birds

Activities that would result in an increase or preservation of habitat for shore birds and other bird species that utilize marsh habitats would benefit peregrine falcons. Birds utilizing these areas would serve as prey for the

peregrine falcon. During construction operations, prey species may leave or avoid the immediate construction site. The peregrine falcon would be expect to forage in adjacent coastal areas.

Piping plovers are not expected to be impacted by HM activities because of this species' close association with sandy beach habitats, typically associated with barrier islands.

5.5.3.4. Mammals

Except for the Atlantic bottle-nosed dolphin (Tursiops truncatus), all other marine mammals can be regarded as rare or accidental users of Louisiana inshore waters because their habits are oceanic. Whales are similarly characterized.

The dolphin typically occurs in the larger, shallow open water bays adjacent to the Gulf where they forage for fish. Thus, HM activities are not likely sources of impacts to this species.

It is possible that Louisiana black bears may occasionally venture into a marsh subjected to HM, especially in the Teche-Vermilion Basin. Those occasions would probably be associated with seasonal wanderings or opportunistic foraging.

5.5.3.5. Cumulative Considerations

Based on available information and general knowledge of the population status of sea turtles, whales, brown pelican, southern bald eagle, arctic peregrine falcon, piping plover, Louisiana black bear, and Gulf sturgeon in Louisiana, previously permitted HM projects are unlikely to have impacted these species.

However, HM water control structures placed in waterways that are near the coast line, or that directly connect with bays or inlets from the Gulf, especially in the Cameron-Calcasieu Basin and the lower portions of the Barataria Basin, should be regarded has having a potential to influence the movement of the Kemp's Ridley turtle. Also in these basins, HM efforts could come to encompass extensive areas of brackish and/or intermediate marsh. That situation, were it to arise, should be regarded has having the potential to indirectly influence a component of this species' food supply.

5.5.4. Summary- Potential for HM Efforts to Effect Significant Biological Attributes

Managers employing HM efforts deliberately attempt to induce specific responses by marsh plants and/or dependent animals, depending upon the purpose of the management effort. HM actions clearly have the potential to impart direct as well as indirect effects on most if not all of the biologically significant attributes that comprise Louisiana's coastal marshes. When a marsh is brought under some form of HM, the biological structure and function of the entire targeted marsh can be unavoidably altered, likely due to self-mediated compensatory adjustments.

Historic HM efforts (i.e., AMM and PMM) appear to induce similar effects on many significant biological attributes. AMM has the potential to have more intensive quantitative effects on targeted as well as non-targeted attributes. The case for HR has yet to be made.

Overall, the general but largely theoretical relationship definging intesity of effects appears to be AMM≥HR≥PMM>unmanaged, a relationship that remains to be conclusively demonstrated. It also is apparently sensitive to and driven by species differences.

Predictively quantifying the response by affected/targeted plants and/or animals in managed marshes is not a precise and unimpassioned effort. Quantifying the effects in managed marshes and surrounding areas on intended as well as unintended biological resources has received less attention and is, therefore, an even more illusive task. The influence of natural meteorological variation on local hydrology would seem to be a manager's ally almost as often as it is an adversary.

Whether management induced differences are beneficial or adverse is in the eye of the beholder. HM efforts intended to expand, or that coincidentally do, result in expanding vegetative coverage can be viewed as favorable if a purpose of the management effort was to forestall, slow, stop or reverse apparent marsh loss. It could also be viewed from a favorable perspective because of the unintended beneficial effects that befall nontargeted species. That exact same management effort if sustained, however, very likely could have an unavoidable and probably adverse effect on actual marsh losses if a compensatory or greater increase in the expected production and retention of slow-to-decay plant materials fails to materialize and the effects on other significant biological attributes are considered (e.g., migratory, estuarine-dependent fish species).

Historic and future management initiatives represent a significant commitment of marsh acreage. If successful, that commitment could encompass a substantial percentage of the remaining significant biological attributes associated with Louisiana's coastal marshes by the year 2010 and beyond.

It remains to be determined to what degree differences in biological attributes between managed and unmanaged areas, as well as HM options, are categorical, site-specific, or some combination of both.

The potential to convincingly argue that unavoidable adverse effects incurred by fish, shrimp and crabs from management can be partially or wholly offset by benefits to wildlife in general and reduced erosion rates would seem to be greatest when management involves the fresh and/or intermediate marsh types.

Past and future research, reports and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree, if any, significant biological attributes are effected by HM efforts.

5.6. **Futures Without (No Action) and With Additional HM: Significant Socioeconomic Attributes**

5.6.1. Hazardous, Toxic and Radioactive Wastes (HTRW)

At a minimum, initial site assessments have been or will be performed by the Federal agency that sponsors a candidate CWPPRA HM project included on priority lists and are subjected to advanced design and analysis.

NOD considers HTRW matters and documents the finding in the record for each permit applications it carries to a decision. This practice is expected to continue.

5.6.2. Fish and Wildlife Resources

5.6.2.1. Commercial

5.6.2.1.1. Historic and Future Without Additional HM (No Action)

This alternative includes the continued operation and maintenance of C/PI HM projects dating back to 1977 and the subsequent implementation of projects with valid permits but for which work has not yet started as of January 1996. Of the 121 applications which were received, permits for 98

projects were issued, and 71 of these have been implemented, are partially implemented or are implementable. Those 71 projects encompass 495,020 acres of coastal marsh. Under this alternative, no additional HM permits would be approved or implemented.

The traditional pattern of commercial fishing is likely to change as the productivity of the marshes declines. Continuation of existing HM practices may slow the loss of marsh, and in so doing, help to preserve and, in some cases, enhance fishery habitat. In many cases, HM would continue to impair access by estuarine organisms. Similar to recent trends, increases from foreign competitors, changes in technology, and declines in the resource base, are factors which could influence the structure and viability of the industry over time.

Controversy and conflict over allocation of the limited resources could increase. Declines in the industry would reduce the positive impacts that the industry currently has on the local and national economies. Losses of income from a reduced level of harvest, processing, sales, and related sales and supplies influencing the industry would result in direct and indirect impacts on the economy of the region. The continuation of HM may increase the number of alligators and thus harvest of these reptiles, especially in managed fresher marsh types.

5.6.2.1.2. Future with Additional HM

This alternative includes the immediate installation, operation and maintenance of all the HM projects described in the Louisiana Coastal Wetlands Restoration Plan developed under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA).

As described under the Historic and Future Without Additional HM paragraph above, implementation and operation and maintenance of the HM projects may not be the most significant factor influencing trends in commercial fishing industry. It is likely that legislative policy may have the most impact on fisheries in the future. The HM projects planned in response to the CWPPRA have the potential to reduce apparent as well as actual marsh loss; these projects will be carefully monitored because some adverse impacts on commercially fished species are possible as large portions of Barataria (68,087 acres), Terrebonne (189,171 acres), and Calcasieu/Sabine (245,434 acres) Basins could come under HM. In addition, controversy and conflict over an increasingly limited resource could occur. In some successfully managed projects, alligator harvest may increase.

5.6.2.2. Recreational

5.6.2.2.1. Historic and Future Without Additional Management (No Action)

The recreational potential of the coastal wetlands is related to wetland availability. The potential for recreational use will diminish as the wetlands are lost. As these resources decline, controversy and conflict over the allocation of limited resources, and access to them, is likely to increase. It is possible that HM projects can prevent loss of marsh, and HM is known to improve habitat for targeted wildlife species. These factors could reduce possible conflict over wildlife resources. However, the continuing reduction of estuarine access that HM appears to cause could increase competition for fisheries resources.

5.6.2.2.2. Future with Additional Management.

If additional HM projects reduce marsh loss, controversy and conflict over resource loss could be reduced. However, a significant HM consideration is how much public access for recreational fishing and hunting will be available as management increases.

The increase in submerged aquatic vegetation encouraged by increased HM should provide more food for wintering waterfowl. However, hunting success will still be influenced by fall flight populations. Fishers will tend to concentrate their efforts at management structures as more and more of these are built. The general restriction on estuarine organism access could have a negative impact on the number and kind of estuarine organisms within managed areas. This possible loss could be compensated by an increase in numbers and kind of freshwater fish within managed areas. We have no hard evidence as to the impacts that would occur outside the managed areas.

5.6.2.3. Cumulative Considerations

The HM projects planned in response to the CWPPRA would have some adverse impacts on commercially fished species in large portions of the Barataria, Terrebonne, and Calcasieu/Sabine Basins. Considering the potentially significant commitment of marsh resources to HM in the future, the success of HM efforts could determine to what degree unmanaged marshes in the Teche-Vermilion and Breton Basins, the marshes associated with the emerging Atchafalaya Delta, and the marsh of the Lakes Sub-basin in the Mermentau Basin, could become the focus of future commercial and recreational fish and wildlife-based endeavors. Should such a development occur, controversy and conflict could arise anew.

5.6.3. Flood Control

5.6.3.1. Future Without Additional HM (No Action)

Over time, developed areas in coastal Louisiana would be more subject to the effects of flooding caused by high river stages, subsidence, marsh loss, sea level rise, and severe weather conditions. In the future, existing levee systems would be maintained and upgraded as needed to provide populated areas with protection from hurricane flooding. Long-term effects of global sea level rise coupled with regional subsidence would make gravity drainage systems work less efficiently and would subject unprotected areas to greater chances of flooding. These same factors wold make it more difficult to successfully operate HM projects.

5.6.3.2. Future with Additional HM

In cases where HM reduces marsh loss, the additional marsh could provide some small amount of protection from storm-induced tidal surges. As sea level rises and the land subsides, HM (especially MM) will become increasingly more difficult to do successfully. Pump assisted management of former HM areas may rise as a future management tool.

5.6.3.3. Cumulative Considerations

HM efforts are clearly site specific efforts. Even with the doubling of the acreage subjected to HM, but especially in the Delta basins where subsidence and sea level rise are claiming marsh rapidly, projects can only be expected to slightly slow the rate tidal surges change.

5.6.4. Land Use and Land Loss

5.6.4.1. Historic and Future Without Additional HM (No Action)

There is little evidence that permitted projects have actualy reversed or stopped marsh (land) loss. HM may have slowed loss in some areas, but this has rarely been scientifically documented. Other benefits such as an increase in waterfowl habitat have been derived. In at least some of these permits, an associated unstated purpose could have been retention of mineral rights.

5.6.4.2. Future with Additional HM

As detailed in Appendix Q, in the Deltaic Plain, projects encompassing 277,872 acres are assumed to be implemented in the future. In the Cheniere Plain, there are likely to be future encompassing 273,674 acres. The assumption implied

by the inclusion of these HM projects in the CWPPRA plan is that they will slow marsh loss.

5.6.4.3. Cumulative Considerations

HM, as a tool to address marsh losses, does not appear to be a highly effective approach for reversing historic land losses. It has the apparent potential to be somewhat more effective at slowing on-going losses and/or delaying losses. But there are bound to be exceptions.

There are corresponding land use implications. Because of the propensity to use property lines and man-created surface landscape features to bound managed areas, and considering the costs to install and operate HM efforts, each hydrologically managed area could be viewed as an independent land use effort. The potential for such areas top be viewed as sites for additional, possibly proprietary economic enterprises has already been evidenced in prior legislative and regulatory actions.

Relating permittee group with funding availability may prove insightful in explaining why some permittees allow their permits to expire without performing any work.

See also- 5.6.2. Fish and Wildlife Resources

5.6.5. Mineral/Petroleum Production

5.6.5.1. Historic and Future Without Additional HM (No Action)

Many previously permitted management plans included design contingencies to accommodate the reality that mineral extraction activities are likely to continue into the foreseeable future. HM is, in many cases, designed to remediate damages or ameliorate impacts caused by mineral extraction/distribution activities.

5.6.5.2. Future With Additional HM

The purpose of some CWPPRA HM projects is also to remediate damages caused by mineral extraction/distribution. Future HM projects will also take into account the reality of continued mineral extraction.

5.6.5.3. Cumulative Considerations

As long as state law links ownership of sub-surface mineral rights with the presence or absence of marsh, protection of mineral rights cannot be ignored as a factor in HM.

Relating partial implementation of permitted projects to surface rights ownership and mineral rights ownership may prove insightful.

See also- 5.6.2. Fish and Wildlife Resources and
5.6.4. Land Use and Land Loss

5.6.6. Displacement of Farms

5.6.6.1. Historic and Future Without Additional HM (No Action)

The continued operation and maintenance of existing HM projects would preserve the status quo in terms of possible saltwater intrusion for a time until relative sea level rise makes it more difficult to control salinities.

5.6.6.2. Future With Additional HM

Placing an additional 551,546 acres under HM could help reduce salinity intrusion into farming areas if at least some of the candidate HM projects were located on/blocked interior routs of entry. Those projects would be effective until such time as relative sea level rise makes it difficult to control salinities with HM.

5.6.6.3. Cumulative Considerations

Many agricultural areas are already under some sort of protection system (e.g., Plaquemines, Terrebonne Vermilion and Cameron Parishes). As marsh losses continue to occur outside of candidate HM project areas, formerly unprotected agricultural areas could become the focus of future protection efforts. The outcome could be to further diminish unimpeded mineral sediment inputs and upland runoff, with a shift to pumps or diversions to shunt sediments and water into nearby-by marshes.

5.6.7. Other Business and Industries

5.6.7.1. Historic and Future Without Additional HM (No Action)

As land loss continues in the future, business and industry outside protected areas may be forced to relocate due to relative sea level rise, even though continued HM may somewhat reduce marsh loss. As the commercial and recreational fisheries decline (for numerous reasons, most unrelated to HM), fisheries-related business and industries may suffer a decline.

5.6.7.2. Future With Additional HM

In cases where HM reduces land loss, some business and industry may avoid relocation. However, since HM does not always curb marsh loss and has no effect on relative sea level rise, many industries and businesses will be forced to relocate landward. Businesses supporting hunting may expand as more land comes under HM. Aquatic vegetation, especially submerged vegetation, should increase and attract more overwintering migratory waterfowl and thus more hunters. On the other hand, businesses supporting the estuarine-based fishing industry may diminish due to reduced catch caused by the curtailment of estuarine organism access.

5.6.7.3. Cumulative Considerations

Because of the high rate of marsh loss in the Barataria Basin and the eastern portion of the Terrebonne basin, the Chenier Basin marshes, the marshes of the Teche-Vermilion Basin, Lake Penchant Sub-basin marshes of the Terrebonne Basin and the marshes of the Pontchartrain Basin could comprise the bulk of the costal marshes that support associated businesses. The concentration and extent of marshes west of the Atchafalaya River could become the hub of marsh related business endeavors.

5.6.8. Property Value and Ownership

5.6.8.1. Historic and Future Without Additional HM (No Action)

Landowners desire to prevent the loss of mineral rights/royalties. Traditionally the bottoms of lakes and bays are considered public property. When an eroded marsh becomes an extension of already state-owned water bottoms, the state is considered to be the new owner of the mineral rights on these newly formed water bottoms. When a landowner slows or stops erosion he prevents any further loss of mineral rights to the state. This is often a basic, but unstipulated, motivation for landowners to elect to undertake HM of marshes.
Controversy also revolves about the ownership of fish and wildlife resources while they are on private land. Some landowners feel that they should have the right to sole ownership and retain the economic value of these harvestable marsh-dependent resources. For a few landowners this is a major source of income and is of great importance. For most landowners this is only a minor source of potential or actual income.

On the other hand, many of the general public believe that these resources are public and that the public has the right to harvest them. The general public believe that resources do not become private property by moving into privately

owned marshes and that these resources should be accessible to the public wherever they are. They also believe that interfering with free movement of fisheries organisms adversely effects the culture, life style and economic fortunes of many people.
Landowners feel exposed to liability and vandalism if they allow unlimited public access to their land. The general public feels that they are improperly perceived by landowners as irresponsible and believe that this is a spurious argument for controlling access. Both access and ownership are questions of the law and will not be resolved by the Corps of Engineers via the permit process.

In the future, as existing HM projects are operated and maintained, the tension between landowners and the general public over ownership of fish and wildlife resources and public access will continue and possibly even escalate as competition for resources dependent on a vanishing landscape feature intensifies.

5.6.8.2. Future With Additional HM

As over 1,046,556 acres of coastal marshes come under HM, tensions between landowners and the public will probably escalate even more rapidly. The positions of each side will likely harden. As the public is denied access to increasing acres of marsh, frustration will grow.

5.6.8.3. Cumulative Implications

This would seem to be an area of potentially great controversy.

Landowners and Limiting Public Access

Nearly all of the water-borne movements within Basin 9, large portions of several sub-basins of Basins 4 and 5 and most of the Chenier Sub-basin of the Mermentau Basin would become restricted to within or between managed area. Nearly all access to and from managed areas and within Basin 9 would entail/be dependent upon the operation and maintenance of man-made structures.

The landowner(s)/leaseholder(s) of the targeted marshes appear to be the most obvious and immediate recipients of any socioeconomic effects that may have arisen from complete or partial implementation. This situation would seem to favorably address the interests of landowners related to trespass, liability and use of marsh-dependent species.

From the Viewpoint of Members of the General Public

Members of the general public seeking to retain access to public resources and seeking to retain existing boat movement patterns would not be favorably affected in many areas subjected to HM.

See also- 5.6.2. Fish and Wildlife Resources and
5.6.4. Land Use and Land Loss

5.6.9. Public Facilities and Services

5.6.9.1. Historic and Future Without Additional HM (No Action)

In the cases where management reduces marsh loss, existing projects may reduce adverse impacts which would otherwise affect these facilities and services.

5.6.9.2. Future With Additional HM

HM that reduces marsh loss would provide some protection to public infrastructure. As increasing amounts of acreage come under HM, the remaining public areas could receive greater hunting and fishing pressure.

5.6.9.3. Cumulative Implications

Even if HM succeeds at addressing marsh losses, pressure on the multi-use of public properties is anticipated to increase.

5.6.10. Employment and Labor Force

5.6.10.1. Historic and Future Without Additional HM (No Action)

The ultimate economic effect of any hydrologic management project is related to what degree the project succeeds and the public's perceptions of that result. The existing projects that are successful in increasing wildlife and reducing marsh loss will probably continue to provide employment to a diverse group of people that manage and utilize these areas. Attempts to resolve the unavoidable disputes among competing user groups will continue to employ many more.

5.6.10.2. Future With Additional HM

As the CWPPRA projects are planned and built, they will provide employment for a wide variety of the above mentioned individuals. If projects are successful, continued direct (e.g., managers, trappers) as well as indirect (e.g., machinery operators, physical geologists, sedimentologists)

employment opportunities will probably be provided for some but could decline for others (e.g., trawl makers). Additionally, new (e.g., eco-tourism) or expanded (e.g., recreational and/or commercial fishing leases) business relationships between users and landowners could arise, or more traditional associations could be modified (e.g., decline in fishers using trawls and boats). Attempts to resolve continuing unavoidable disputes will continue to be an indirect source of employment for some, mostly in government positions.

5.6.10.3. Cumulative Implications

Even if HM efforts succeed at slowing marsh losses, the number of jobs is likely to diminish and possibly become more commonly associated with the remaining wetlands in the Chenier marshes and portions of the Delta marsh complex. Would seem to be a fertile area for academic inquiry.

5.6.11. Income

5.6.11.1. Historic and Future Without Additional HM (No Action)

If existing HM projects are successful, they will provide continued, but limited, employment opportunities. However, the reduced estuarine organism access could cause a reduction in income to commercial fishers and the fisheries support industries which cannot be quantified at this time. Income from oil and gas leases and trapping, hunting, fishing, and cattle grazing will continue to accrue to landowners and the State.

5.6.11.2. Future With Additional HM

As the several CWPPRA HM projects are built, construction will provide a limited income locally. Income of traditional, non-landowning commercial fishers could drop as could income derived from support to the recreational fishing industry. These HM projects should allow landowners/leaseholders to retain and/or expand their existing incomes and mineral royalties, assuming demand remains constant or increases.

5.6.11.3. Cumulative Implications

The traditional sources of income appear to be linked to what at one time were probably perceived to be fairly inexhaustible resources (i.e., marsh dependent species, oil and gas revenues).

Money, in large amounts, is required to plan, install,

operate, monitor and maintain HM efforts. CWPPRA funding is insufficient to fund all the candidate HM projects. Future HM efforts are likely be funded from CWPPRA as well as non-CWPPRA sources.

If HM efforts are perceived as investments (as non-CWPPRA funded projects might tend to be), then HM efforts will likely be pursued only so long as the investor perceives there to be an attractive yield. Incremental installation of projects maximizes the opportunity to redirect limited monies to better investments as circumstances change. This concept may partially explain why some projects are permitted or only partially implemented before the permit expires.

In other words, in some cases the permittee may decide that there are better investment opportunities. The matter only becomes of direct interest to the NOD if a project is only partially implemented.

5.6.12. Displacement of People

5.6.12.1. Historic and Future Without Additional HM (No Action)

No action would result in a continuation of existing trends (i.e., continued out migration due to land loss or economic "hard times"). As physical land loss continues, it is possible that some communities may need to be relocated to higher ground or undertake construction of protective structures.

5.6.12.2. Future With Additional HM

The HM projects that do successfully prevent marsh loss may locally help prevent or forestall out migration and relocation of individuals and perhaps communities by sustaining economic livelihood. As extensive areas are brought under HM, there may be some limited displacement of traditional commercial fishers if the fishery declines due to reduced access for young shrimp and fish.

5.6.12.3. Cumulative Considerations

See 5.6.8. Property Value and Ownership

5.6.13. Tax Revenues

5.6.13.1. Historic and Future Without Additional HM (No Action)

A moratorium on new HM projects could possibly eventually

lead to a weakening of the local/municipal tax base in communities where land loss continues to occur. As the present marsh becomes state-owned water bottoms, the state could gain more revenue from oil and gas production.

5.3.13.2. Future With Additional HM

The HM projects proposed under CWPPRA could reduce the productivity of commercially harvested fish and shellfish, or reduce the productivity of sport fish in ways which could eventually impact the local economy and subsequently affect the tax base of a nearby community. These effects may appear incremental but could be significant when combined with other HM projects in the same general vicinity. It is possible that the state could lose possible future revenue when HM prevents areas being declared state-owned water bottoms. Perpetuation of revenue streams may precipitate new ways to tax resources derived from managed areas.

5.3.13.3. Cumulative Considerations

Changes in tax revenues are likely to change over time and between basins.

See also- 5.6.10. Employment and Labor Force
5.6.11. Income

5.6.14. Community and Regional Growth

5.6.14.1. Historic and Future Without Additional HM (No Action)

HM projects which contribute, either directly or indirectly, to continued economic development in areas along the coast, may have a beneficial impact on community and regional growth. Conversely, if a project is determined to have an adverse effect on resources valuable to a community or region, such as fisheries, the effect could be adverse.

5.6.14.2. Future With Additional HM

As 571,645 acres could be brought under HM, as described above, there exists a potential for both beneficial and adverse impacts to community and regional growth.

5.6.14.3. Cumulative Considerations

Some redistribution of population could arise, as coastal marshes continue to be lost. It would probably be in response to changing economic forces and/or susceptibility to flooding. If HM proves successful on a large-enough scale, any redistribution that may occur could be smaller

and occur over a longer time.

See also- 5.6.2. Fish and Wildlife Resources
5.6.4. Land Use and Land Loss
5.6.5. Mineral/Petroleum Production
5.6.7. Other Business and Industries
5.6.10. Employment and Labor Force
5.6.12. Displacement of People

5.6.15. Health and Safety

5.6.15.1. Historic and Future Without Additional HM

Continued HM may contribute to the safety of communities and the region to the degree that it may reduce land loss and flood hazards.

5.6.15.2. Future With Additional HM

Where HM reduces marsh loss, the additional marsh could provide some protection from storm-induced tidal surges.

5.6.15.3. Cumulative Considerations

If HM proves successful on a large enough scale, damages and health problems associated with storms may be deferred and/or not occur as widely or prove to be as costly over a longer term.

The effect of wide-scale HM on the quality/suitability of marsh-derived "seafoods" (e.g., oysters, shrimp, crabs) for human consumption is unknown.

5.6.16. Community Cohesion

5.6.16.1. Historic and Future Without Additional HM (No Action

The mutual interests and socioeconomic viability of communities along the coast could decline as marsh loss continues and competition for marsh-dependent resources intensifies.

5.6.16.2. Future With Additional HM

Given the recent controversy between competing user groups over the apparently declining fishery resources, as extensive areas come under HM, conflicts between these groups would in all probability intensify. As landowners exert tighter controls over access, it is possible that commercial fishery sharecroppers may evolve.

5.6.16.3. Cumulative Considerations

Successfully slowing, stopping or reversing marsh losses or improving wildlife habitat conditions with HM may not reduce, eliminate or foster an amicable resolution of all socioeconomic conflicts. Thus, some of the socioeconomic issues related to HM appear to be irresolvable. For these reasons, the probability that HM efforts have had, are having and probably will continue to have socioeconomic effects that are significant and disruptive of at least to some segments of the population cannot be ruled out, as evidenced by recent actions of the Louisiana state relative to commercial and recreational fishing interests.

5.6.17. Aesthetics

5.6.17.1. Historic and Future Without Additional HM (No Action)

As the marshes become open water, to many, their aesthetic values will continue to decline. HM projects that successfully arrest marsh loss will slow the decline in aesthetic value.

5.6.17.2. Future With Additional HM

Since the HM projects under CWPPRA are planned to reduce and not eliminate adverse effects, and since success is not assured, the decline in aesthetic values associated with the wetlands can be expected to continue, although at somewhat lower rates.

5.6.17.3. Cumulative Considerations

Any decline is offensive to some, sometimes simply because it is unavoidable in some cases. HM, especially MM, is offensive to some for a number of reasons. A landscape dotted with site-specifically successful HM project areas may also be offensive to some. A landscape dotted with less than fully successful or prematurely abandoned HM project areas could possibly be offensive to an even wider range of individuals.

5.6.18. Noise

5.3.18.1. Historic and Future Without Additional HM (No Action)

No significant adverse impacts to human health are anticipated as a result of noise associated with HM projects. Most HM projects are in relatively remote areas. It is possible that maintenance-induced noise would

temporarily impact wildlife in the vicinity of the construction. Some aspects of their breeding biology could be impacted unless construction is timed to avoid such times.

5.6.18.2. Future With Additional HM

There would be additional noise associated with construction of HM projects. However, impacts would be minor due to the remoteness of most sites.

5.6.18.3. Cumulative Considerations

None foreseen.

5.6.19. Environmental Justice

5.6.19.1. Historic and Future Without Additional HM (No Action)

Overall, managing Louisiana's coastal marshes is now practiced in a way that adversely affects low income and some minority populations to a slight degree.

5.6.19.2. Future With Additional HM

The slight adverse impacts to low income and minority populations due to access problems would become more apparent as more and more land comes under HM.

5.6.19.3. Cumulative Considerations

HM, especially MM, could disproportionately affect some groups more so that others. However, if HM generally succeeds at slowing marsh losses in the long-term without disrupting the economic relationships between low income groups or minority groups, it may be possible to conclude that low income or minority populations (e.g., ethnic minorities) were adversely affected minimally only in the short-term. However, a landscape dotted with less than fully successful or prematurely abandoned HM project areas could possibly affect and inherent relationships that currently exist.

5.6.20. Existing Approximations of Structural Management Feasibility

Several C/PI/I as well as candidate CWPPRA HM projects are located in areas where feasibility would not be considered optimal (Cahoon and Graot 1990). Those projects would seem to require greater effort and probably be more costly in install, operate and maintain. As a result, they could also

be candidates for premature discontinuation of management operations.

5.6.21. Summary

The sources and types of controversy surrounding the management of Louisiana's coastal marshes, and the fate of the marsh-dependent organism that are effected by management, suggests the possibility that the roles are being redefined of public and private entities in the stewardship of public trust resources relative to the rights and privileges of landowners and leaseholders. Landowners/leaseholders are clearly entitled to protect their private property, mineral interests and control trespass. Through the Corps of Engineers' permit program and the public funds to implement CWPPRA projects on private properties, landowners/leaseholders are aggressively asserting and rapidly acquiring a role as stewardship partners with public resources managers. The question arises: to what extent, if at all, does a landowner's/leaseholder's concern for protecting property rights extend to or encompass public trust resources that they help steward? A companion question is what laws apply or may be necessary to address liabilities if public access is required pursuant to the expenditure of public monies on private lands. Answers to those questions would seem to have wide ranging socioeconomic implications.

5.7. Futures Without (No Action) and With Additional HM: Significant Cultural Attributes

The Cultural Appendix (Appendix J) includes a description of the procedures used to identify cultural resources associated with project sites and activities and actions taken to reduce/avoid adverse impacts to those resources or any discovered during construction of authorized projects. Those procedures were used during the processing of previously permitted projects.

An assessment of the potential to affect cultural resources can go no further at this time. To complete the assessment requires knowing precisely where management structures and construction and maintenance activities would occur. Once advanced project designs are formulated and an analysis of a project is initiated, the procedures used to characterize and reduce/eliminate adverse impacts to resources encompassed within or nearby to previously permitted projects would be used during the processing of applications for future projects.

5.8. **Synthesis/Summary and Regulatory Implications**

5.8.1. Synthesis/Summary

Every HM project has a stipulated purpose or purposes. One or some combination of the following inferences should apply to any HM project: 1) the prevailing and future conditions are incompatible with the purpose(s); 2) the prevailing and future conditions will not change without some deliberate and intentional action to amend or override those conditions; and/or, 3) future conditions with some form of HM are better than the prospects without management.

Hydrologic management (HM) of marshes attempts to create and maintain discontinuities between managed and unmanaged areas. Selectively and differentially controlling several hydrologically-influenced attribute(s) of a marsh is typically required to set in motion a chain of events leading to the desired management outcome. Outcomes typically focus on selected biological and socioeconomic marsh-dependent attributes.

Improving habitat conditions for targeted marsh-dependent animal species was historically the single most important reason to conduct HM, driven by the socioeconomics of the targeted marsh-dependent species. During the last 10 years, addressing marsh losses has emerged as the foremost stipulated reason to pursue HM of Louisiana's coastal marshes.

Proponents and opponents of HM agree about the necessity to forestall, slow, stop or reverse coastal Louisiana's marsh losses. But as the use of site-specific HM efforts proliferated, conflicts between groups that compete for access to and the use of marsh-dependent resources also escalated. The conflict arose because: 1) regardless of the purpose for a project and whether or not the project worked, the design and operation of HM structures were offensive to some marsh user groups; and, 2) there was doubt about how effective historic HM efforts could be when applied to marsh loss situations.

In coastal Louisiana where coastal marsh landscapes are vanishing rapidly, the move towards a greater emphasis on HR as a way to address marsh losses presented three challenges: 1) developing tactics and strategies to address historic and future marsh losses, without totally losing sight of historic applications; 2) determining the physico-chemical, biological, socioeconomic and cultural consequences of applying those tactics and strategies; and, 3) recognizing and balancing the interests of the competing, marsh-dependent user groups in the face of already limited and

declining marsh resource.

The first challenge was taken up by managers and other Federal and state agencies mandated to and capable of developing tactics and strategies. NOD's role is different. Through its regulatory obligations, NOD determines impacts and effects and balances interests pursuant to rendering objective decisions about permit applications that would authorize the installation, operation and maintenance of structures and/or activities required to conduct hydrologic management efforts that comply with several Federal laws.

Over the years, NOD has issued 98 permits. Seventy-one have been implemented to some degree or could be implemented. Those 71 permits could influence 495,020 acres. Given the CWPPRA initiative, the trend to address coastal marsh losses with HM efforts is not likely to abate. Thus, NOD may have to render decisions about permits that could involve up to as much as 551,546 additional acres, which could bring the total of permitted HM efforts to 1,046,566 acres coastwide.

The draft and final versions of this PHMEIS reflect NOD's recognition of the potential for those permit decisions to have programmatic significant effects.

Preparation of this PHMEIS revealed that:

1) there are no simple or definitive answers to questions as broad as: "How well do MM and HR projects work?"; "Why do they seem to work better in some places than others?"; and "What are the impacts and effects associated with HM projects?"; or "To what degree are managed areas rendered immune from future losses?"

2) practitioners of MM (or HR) cannot control the climate, geologic processes or the complicated socio-economics associated with Louisiana's coastal marshes. Managers: a) set in motion a chain of events intended to culminate in the desired management outcome; b) take advantage of favorable meteorological, surface geomorphology and hydrologic conditions while and where they exist; and, c) regain hydrologic control as soon as possible after uncontrollable and unpredictable counterproductive conditions (e.g., tropical weather systems, prolonged periods of little or no rain fall) pass. If successful, the processes, structure and function that come to characterize managed marsh will differ from nearby unmanaged marshes.

3) anecdotal, primarily observational reports still form the bulk of the literature. Those reports typically focus upon how targeted plants and animals

(e.g., submerged aquatic vegetation, waterfowl) responded to management efforts. Long-term, objective monitoring/performance data are still rare. Studies focusing on demonstrable cause and effect relationships are becoming generally more accessible and used in impact forecasting since the late 1980's. This fact became apparent when we examined the literature applicable to the significant attributes.

4) predicting how and at what rate Louisiana's coastal marshes and dependent resources will respond to any specific HM activity has not, is not and likely will not become a precise, unimpassioned, purely objective, quantitative effort in the foreseeable future. There has been no rush to objectively and comprehensively examine some of the less glamorous but nonetheless influential functional relationships. Reliance upon the documented record, tempered with the collective abilities and wisdom of professionals and managers when necessary, would seem to represent a strategy for forecasting what the biological response(s) to individual HM projects could reasonably be.

5) in many but not all instances, HM-induced differences between managed and unmanaged areas appear to be expressed as degrees of unavoidable reciprocal, apparently self-mediated, compensatory shifts. The degree to which managed areas can be differentiated from the rhythms and dynamics of surrounding marsh systems appear to dictate the ability of managers to sustain induced differences or accommodate other significant resources (typically migratory estuarine-dependent fish). Typically, any such accommodations are undertaken only in so far as they don't compromise other interests of the permittee.

6) at this time, the reversal of marsh losses (actual marsh gain) through the application of HM is one possible outcome but not the most probable long-term outcome from applications of HM. Forestalling (i.e., deferring until some later time) and site-specifically slowing the rate marsh losses occur appear to be the most probable long-term outcomes from applications of HM.

7) issuance of a permit for HM does not always correspond to full and complete project implementation. The final disposition of a permit is not obviously related to any of a number of attributes related to permitted projects.

8) project-derived benefits from issued permits can be

expected to fall short of expectations, at least in the short-term. No work/permit expired projects, as well as partially implemented projects with expired permits, would seem to be opportunities lost by permittees to address historic marsh losses, targeted animal species and/or future marsh losses. Incompletely implemented projects were assumed to involve additional site-specific effects. Some effects may be detrimental, possibly destructive (some may be irreversible if dredging of marsh is involved) to some significant biological attributes. The landowner(s)/leaseholder(s) of these targeted marshes appear to be the most obvious and immediate recipients of any socioeconomic effects that may have arisen from partial implementation, which fosters questions about the intentions, expectations and capabilities of permittees, as well as the role of agencies, in project planning.

9) in the future there is a potential for significant effects, focused in the Barataria and Terrebonne Basin of the Delta Region and both Chenier Region Basins. In all three areas the potential arises more so from candidate CWPPRA HM actions. However, in the Calcasieu-Sabine Basin effects from historic management may already have had effects on the Calcasieu River estuary. Because nearly all of the wetland/water complex of that basin could be brought under management, there is also the potential for significant impacts that might extend beyond the basin's boundaries, possibly involving Sabine Lake as well as the marshes between Calcasieu Lake and Lake Charles.

10) any management effort, whether it succeeds or fails, involves trade-offs. The biological or ecological benefits or damages proponents as well as opponents of MM or HR can call upon to support their respective positions have typically proven to be real or probable and almost invariably have socioeconomic overtones.

11) in some instances, in certain areas and/or for certain purposes, MM can be, and HR has the potential to be, effective and may result in acceptable levels of unavoidable adverse impacts, whereas in other circumstances management efforts may be ineffective at best and can be extremely detrimental to one or more significant attributes either locally or on a much broader scale.

12) socioeconomic issues appear to be the result of the existing and increasing friction between competing user groups and not always compatible needs and interests of

landowners/leaseholders and some members of the general public. So far, even site-specifically "successful" MM efforts have not eliminated the friction.

13) proponents of HM assert that suppressing the conversion of vegetated marsh surfaces to open water and/or managing for marsh dependent animal species are compatible and complimentary. To them that relationship is so compellingly beneficial to the socioeconomics at play that the benefits outweigh any of the adverse biological/socioeconomic results that are unavoidably induced/arise, even if the targeted marsh losses occurred decades ago. With emphasis on HR in the future, many of the traditionally targeted marsh-dependent animals will less often be targeted and more often be indirect and possibly even unintended beneficiaries of HM efforts.

14) opponents of HM assert that the benefits are not so self-evidently overwhelmingly. Rather they are suspect because:

a) the spectrum of potential adverse consequences remains to be characterized sufficiently to yield useable, quantitative approximations of impacts;

b) an inability to value those consequences a reliance on demonstrable adverse consequences could greatly underestimate the overall consequences; and,

c) the current permit evaluation process is not sufficiently appreciative of/sensitive to the adverse economic and cultural consequences to specific user groups.

There is merit to some of their assertions.

15) successfully slowing, stopping or reversing marsh losses with MM or HR may not reduce, eliminate or foster an amicable resolution of all socioeconomic conflicts. Thus, some of the socioeconomic issues related to MM and HR appear to be irresolvable. For these reasons, we cannot rule out the possibility that MM and HR have had, are having and probably will continue to have socioeconomic effects that are significant, at least to some segments of the population.

16) the existing socioeconomic data leave us less than fully prepared to accurately and repeatedly profile and predict the socioeconomic concerns specifically

associated with HM of Louisiana's coastal marshes. An in-depth examination of the socioeconomics of HM would seem to be fertile ground for investigation if predicting outcomes to permitted projects and/or formulating more insightful permit conditions were determined to be necessary.

17) generally poor monitoring compliance -

a) has and could continue to hinder the detection and characterization of normal variation, appropriately reacting to real differences, or explaining responses to HM efforts

b) prolongs dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue the merits of each management action.

5.8.2. Regulatory Implications

1) For each and every permit evaluated, NOD is required to document its findings relative to its examinations and evaluations of the practicability of alternatives, as well as impact reduction/mitigation efforts, that don't preclude the project achieving its stated purpose and need.

2) NOD is not an agent of change. NOD is neither empowered nor obligated to reconcile apparently contradictory points-of view between competing user groups before a permit can be issued. Nor is NOD obliged to deny a permit because of apparent contradictions or scanty information.

3) NOD cannot compel permittees to install projects once a permit is issued. But, NOD can hold them accountable for their actions once authorized activities are initiated. The justification for any follow-up that might be determined to be appropriate reflects the following:

* An assumption, applicable to many if not most or all permitted HM projects, and especially those that include MR as a project purpose, is that the targeted marsh is "better off" with management than without. This assumption would surely seem to apply to the permittees perspective. From NOD's perspective, the project, as depicted in the drawings that are part of an issued permit, was determined to comply with federal and state statutes and laws and to not be contrary to the public interest as reflected in analyses and NEPA documents prepared in support of the permit decision.

* In the case of partially implemented HM projects and

for permittees that failed to submit the required monitoring reports, the situation does not agree with the administrative record on file.

Accordingly, NOD could elect to review any or all such cases to determine what if any subsequent regulatory actions might be required.

4) NOD could continue to update and maintain the HM data base, and coordinate this information with the concerned Federal and state agencies.

5) NOD could more rigorously follow-up on permit monitoring requirements.

6) NOD could attempt to identify the reason(s) why permit issuances didn't equate directly to project implementation, and partial implementation occurred more prominently in some basins and not others.

Those permit outcomes could be artifacts of NOD's permit data and/or NOD's permit follow-up process. However, if the permit and follow-up data are reasonably accurate, then they could reflect many things. For example, the different corporate and private/governmental implementation profiles suggest that:

a) some permittees would seem to disagree with Federal and state regulators about what was really necessary to achieve stipulated purposes;

b) unstipulated purposes could have been as compelling, or more so, than the stipulated purposes for some permittees; and,

c) the circumstances that would suppress implementation (e.g., uncertain construction schedules, rising costs and/or interest rates making other uses for the money more profitable, certainty of funding sources, whether or not the money is irreversibly dedicated) disproportionately influence corporate and government permittees. A more detailed analysis may reveal other explanations.

7) NOD could attempt to determine why poor monitoring follow-up by permittees occurred, to include examining the following reasons:

a) perhaps it took so long to start work that permittees simply forgot about the monitoring provision. Perhaps the language of the condition was

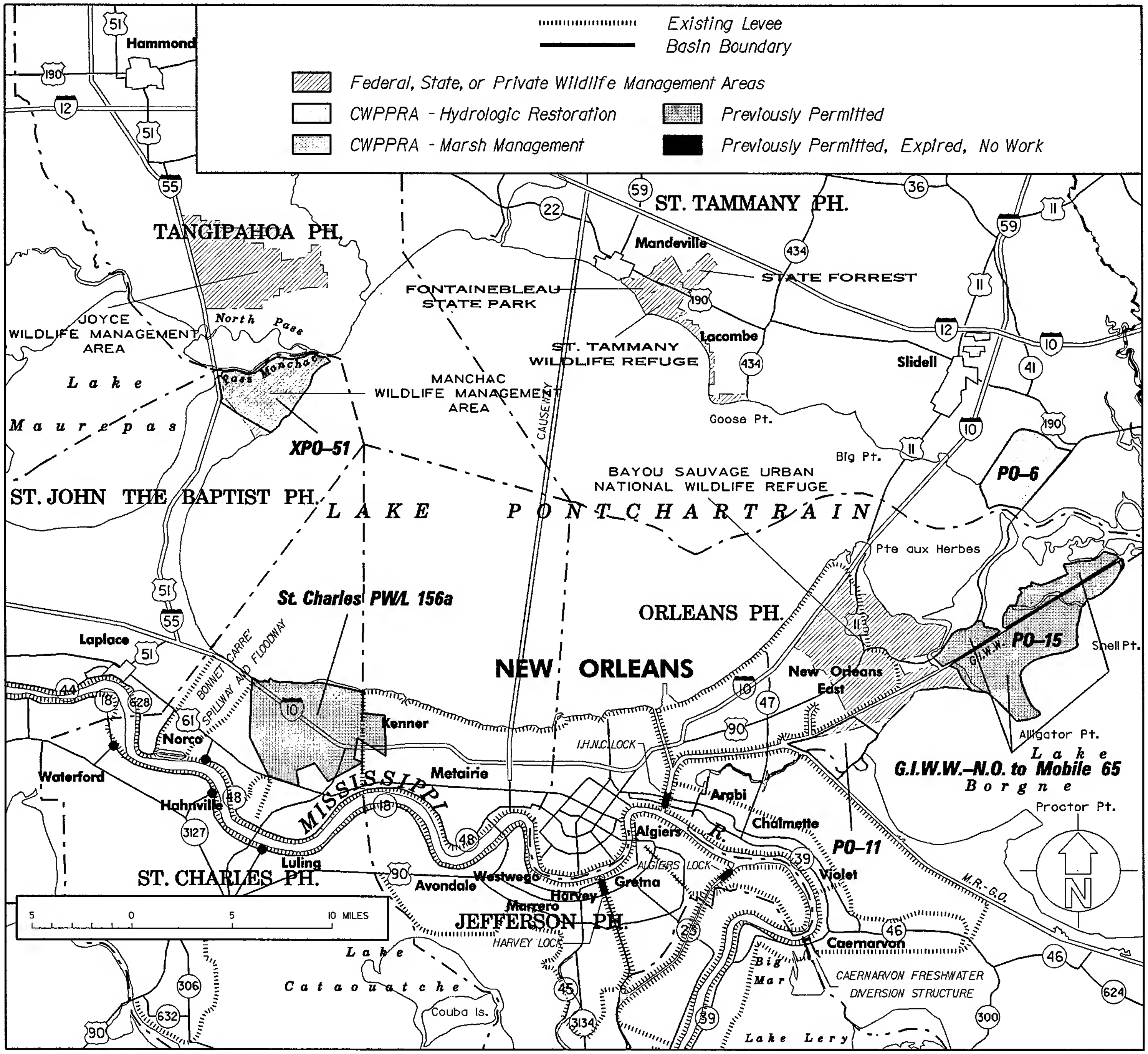
ambiguous. For example, if monitoring was to start upon implementation of the project, did that occur when work was first started or when the last project feature was installed and the plan became fully operational? Quite a bit of time can pass between these two stages of the project. Perhaps full implementation was perceived to be the threshold for undertaking monitoring. In that case partial installation of a project, whether subsequently abandoned or not, could have been interpreted by the permittee as not being subject to monitoring.

b) the typical design of most management efforts targeting wildlife species and the partial implementation of projects followed by permit expirations suggests the possibility that some such efforts were undertaken, at least in part, pursuant to addressing other proprietary socioeconomic interests (e.g., protection of property rights, mineral rights). If so and if partial implementation successfully addressed the socioeconomic motives, the inconvenience and out-of-pocket costs to comply with permit monitoring conditions could have been avoided by arguing the ambiguity of implementation and/or simple forgetfulness to a regulator.

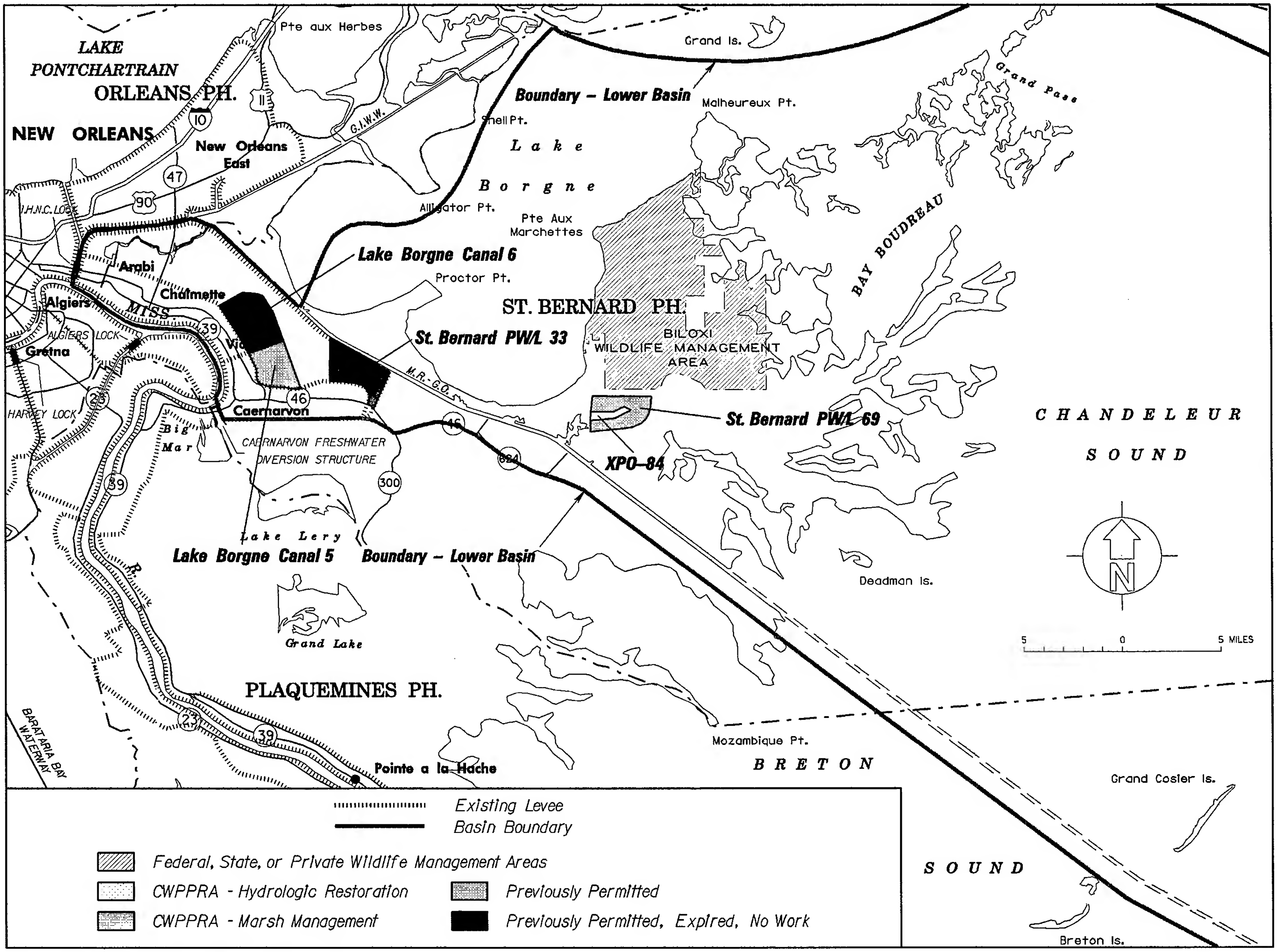
Clearly, there is imprecision as well as uncertainty in characterizing the effectiveness of HM efforts to address marsh loss as well as targeted species. Regulators must be aware of those imprecisions and uncertainties. They must evaluate the inevitable and unavoidable trade-off between the "benefits", whether intentional or coincidental, against the clear potential for unavoidably "adverse" biological and/or socioeconomic conflicts that could result for each and every project submitted for permit consideration. In most cases the best available information may only be insightful for formulating professional judgements.

Improved permit decision-making could result if there existed a comprehensive characterization of the socioeconomic implications of HM, if there were greater compliance with monitoring provisions by permittees, better designed monitoring programs, as well as ready access to a larger number of rigorous scientific studies of selected biological attributes, and some way could be devised to determine which projects installed in what sequence would approach or exceed to-be-defined thresholds of physico-chemical, biological, socioeconomic and/or cultural significance. Although NOD can take steps to improve monitoring and monitoring compliance, NOD's role relative to initiating additional studies remains to be determined.

PLATES



Pontchartrain Basin (Basin No. 1)



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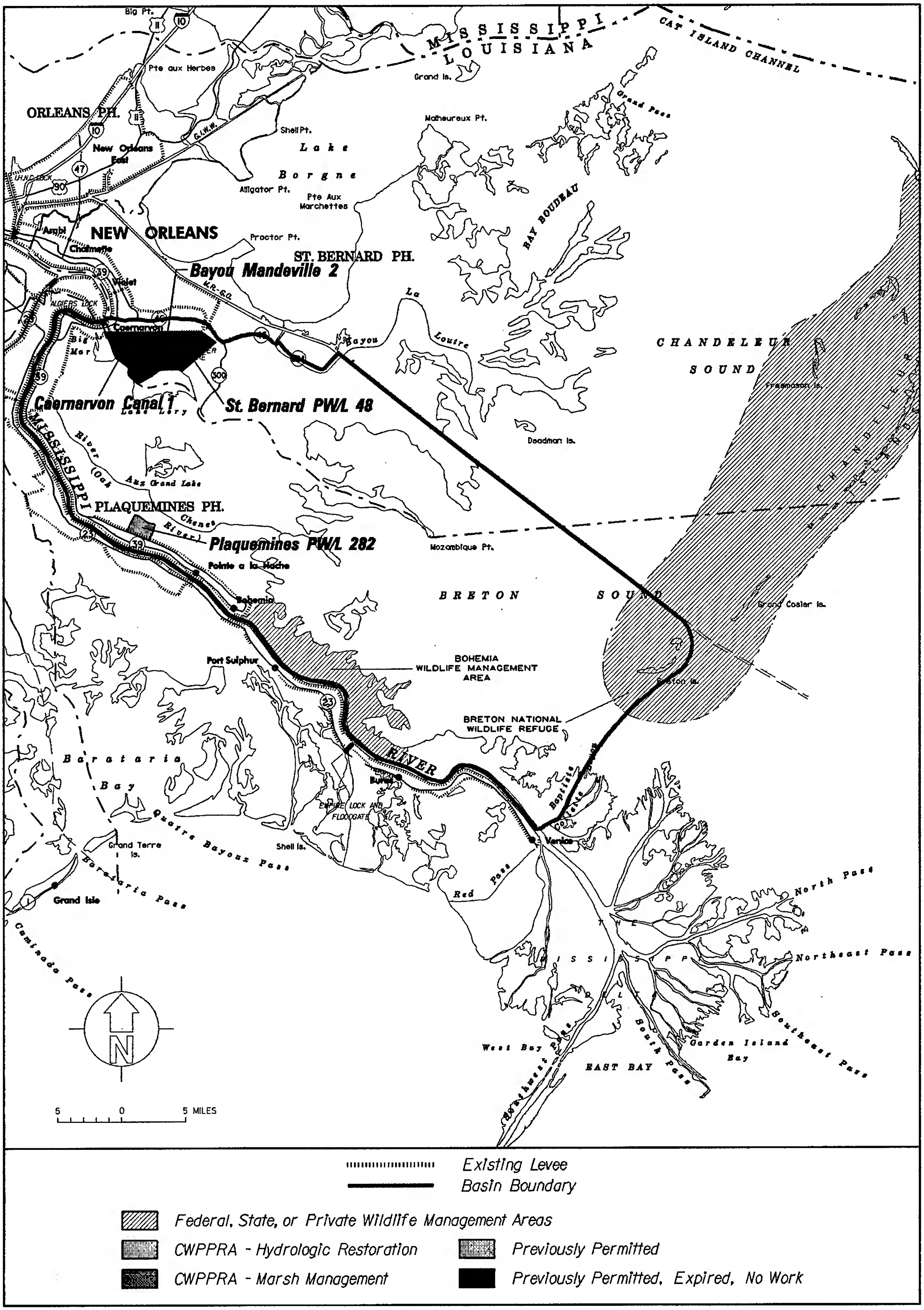
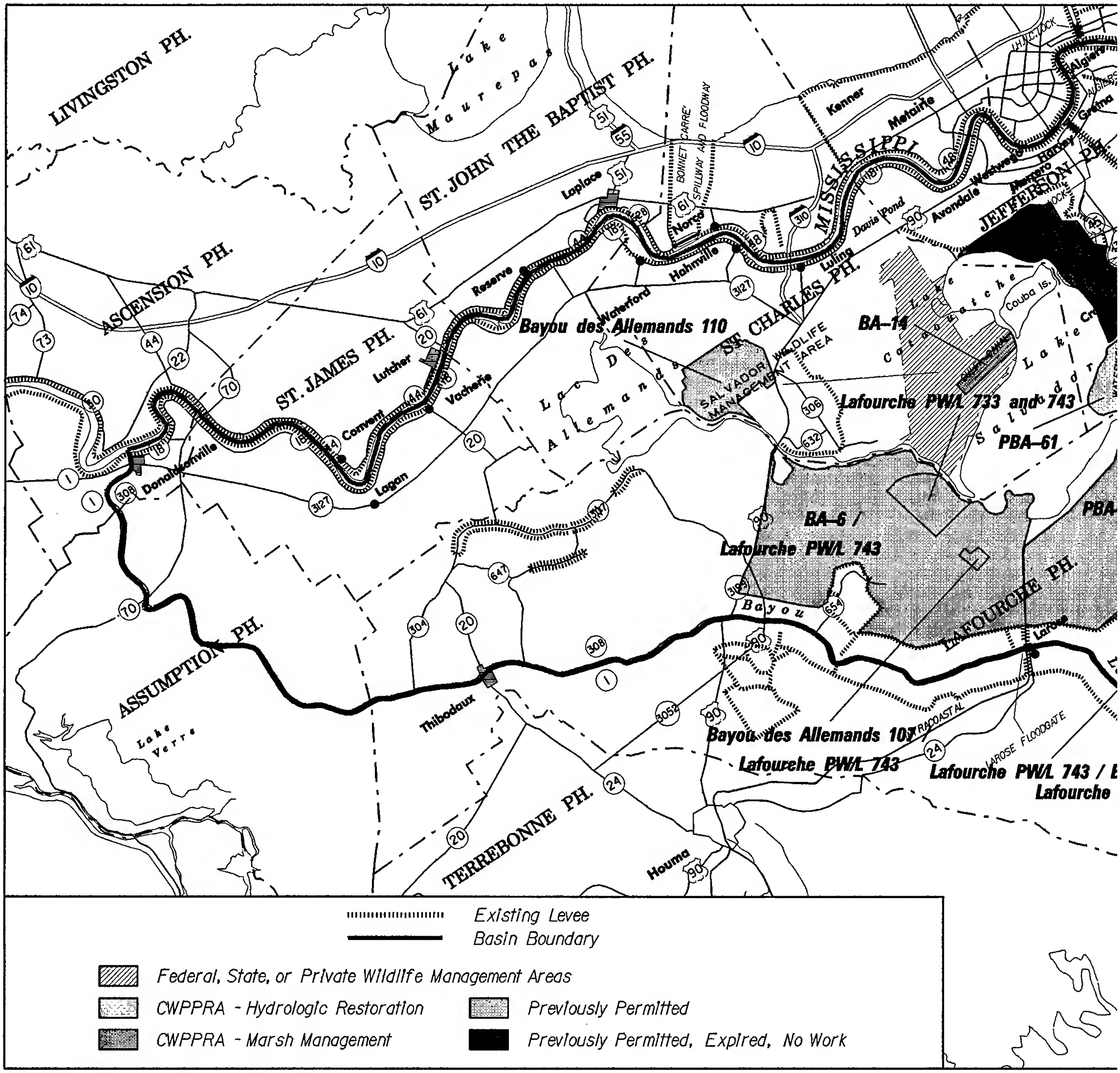


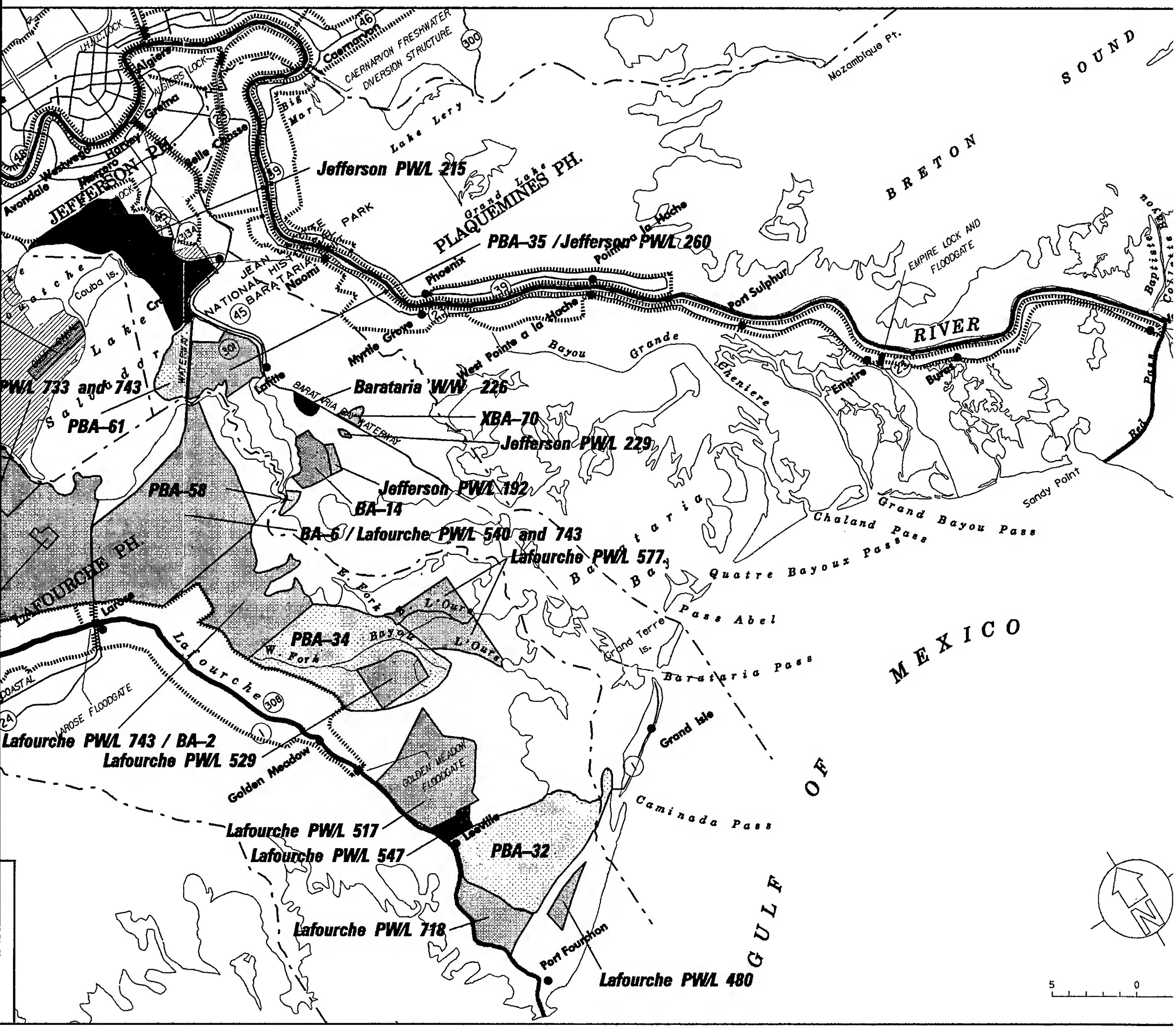
Breton Sound Basin (Basin No. 2)

1



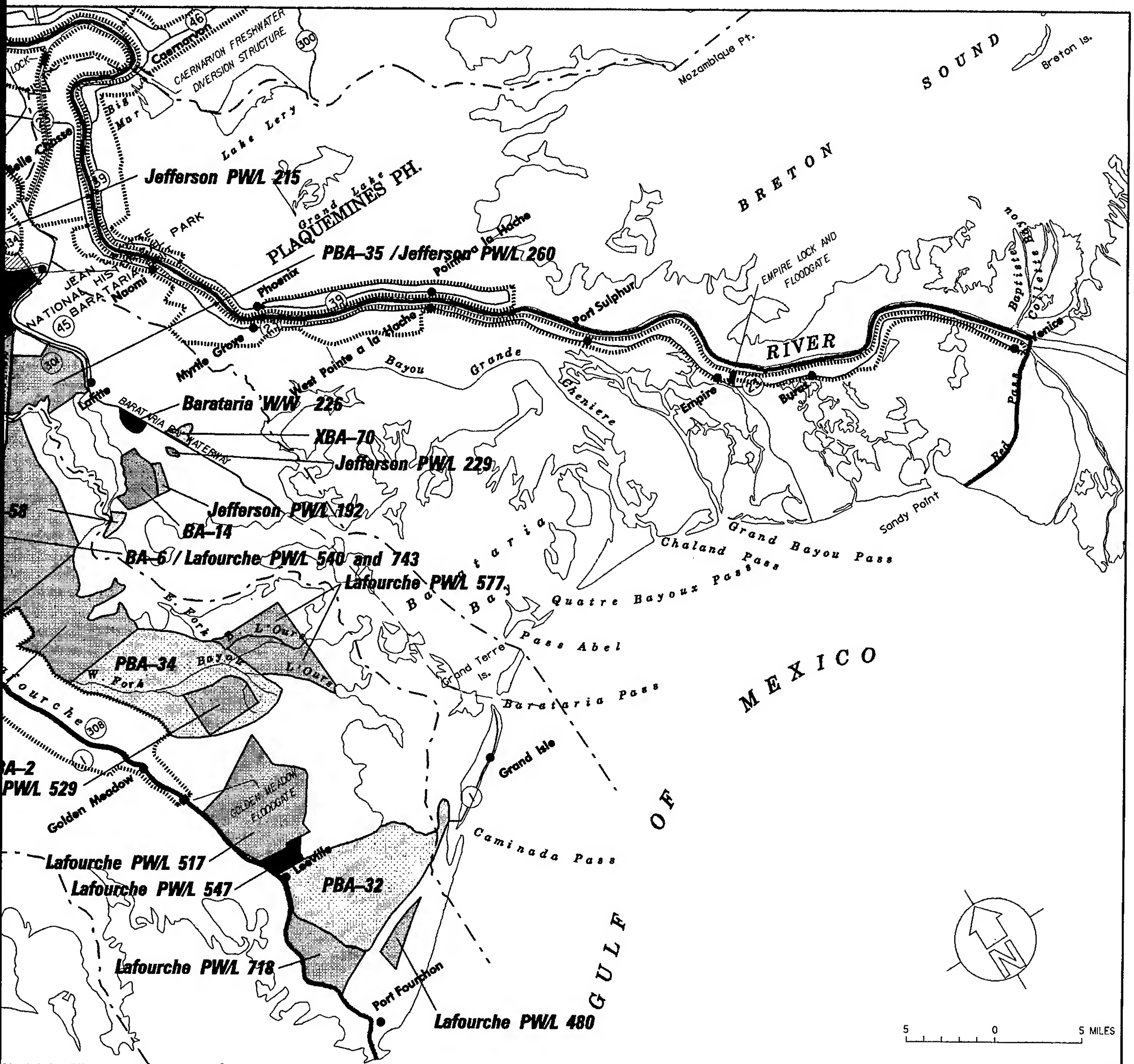
Barataria Basin (Basin No. 4)

2



Jefferson PW/L 215
PBA-35 /Jefferson PW/L 260
PW/L 733 and 743
PBA-61
Barataria W/W 226
XBA-70
Jefferson PW/L 229
Jefferson PW/L 192
BA-14
PBA-58
BA-6 / Lafourche PW/L 540 and 743
Lafourche PW/L 577
PBA-34
Lafourche PW/L 743 / BA-2
Lafourche PW/L 529
Lafourche PW/L 517
Lafourche PW/L 547
PBA-32
Lafourche PW/L 718
Lafourche PW/L 480
JEFFERSON PH.
PLAQUEMINES PH.
LAFOURCHE PH.
BRETON SOUND
RIVER
GULF OF MEXICO
CAERNARVON FRESHWATER DIVERSION STRUCTURE
EMPIRE LOCK AND FLOODGATE
GOLDEN MEADOW FLOODGATE
LAROSE FLOODGATE
Caernarvon
Algiers
Gretna
Harvey
Marrero
Westwego
Avondale
Belle Chasse
Lafitte
Naomi
Phoenix
Myrtle Grove
West Pointe a la Hache
Pointe a la Hache
Port Sulphur
Empire
Buras
Larose
Golden Meadow
Leeville
Port Fourchon
Grand Isle
Lake Lery
Mozambique Pt.
Couba Is.
Bayou Grande
Cheniere
Barataria Bay
Chaland Pass
Grand Bayou Pass
Sandy Point
Quatre Bayoux Pass
Pass Abel
Grand Terre Is.
Barataria Pass
Caminada Pass
Bayou Lafourche
E. Fork B. L'Ours
W. Fork
BARATARIA WATERWAY

3



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BA-14
BA-6 / Lafourche PW/L 540 and 743
Lafourche PW/L 577
PBA-34
PW/L 529
Lafourche PW/L 517
Lafourche PW/L 547
PBA-32
Lafourche PW/L 718
Lafourche PW/L 480
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Caernarvon
Mozambique Pt.
Breton Is.
BRETON SOUND
Lake Lery
Grand Lake
PLAQUEMINES PH.
JEAN LAFITTE NATIONAL HISTORICAL PARK BARATARIA
Naomi
Phoenix
Pointe a la Hache
West Pointe a la Hache
Myrtle Grove
Port Sulphur
EMPIRE LOCK AND FLOODGATE
Empire
Buras
RIVER
Venice
Baptiste Collette Bayou
Red Pass
Bayou Grande Cheniere
Lafitte
BARATARIA BAY WATERWAY
Barataria Bay
Chaland Pass
Grand Bayou Pass
Sandy Point
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Lafourche
Golden Meadow
GOLDEN MEADOW FLOODGATE
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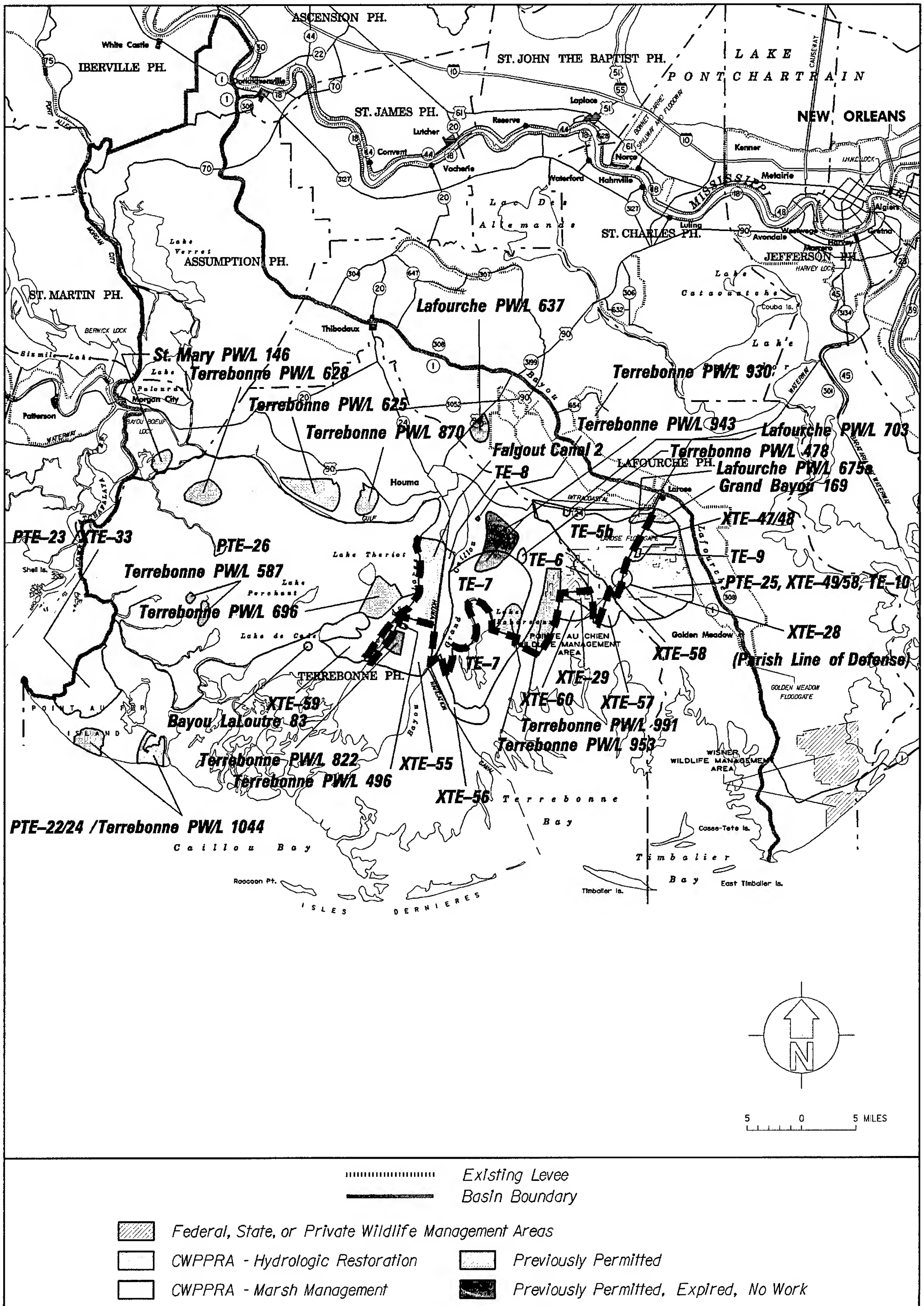
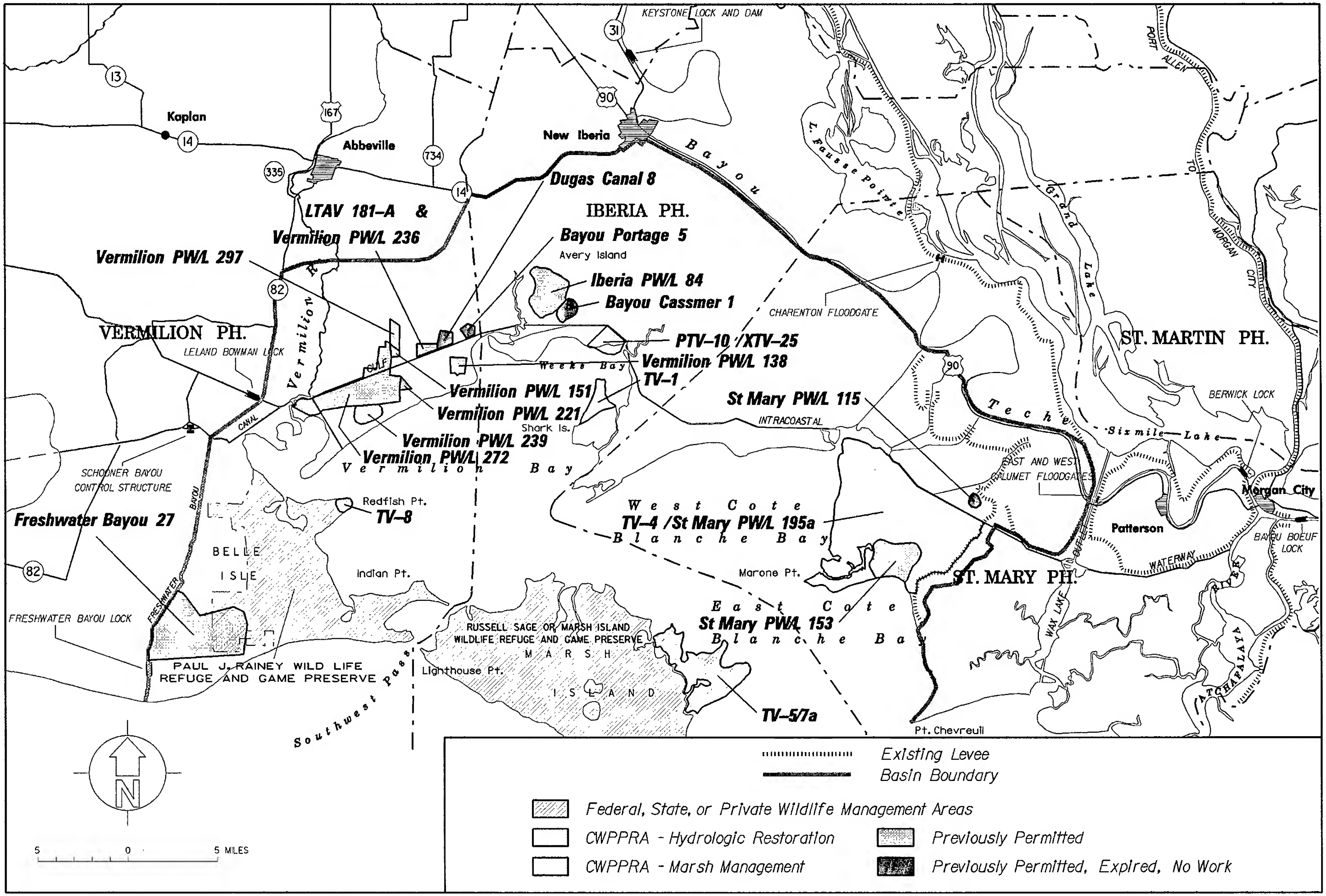
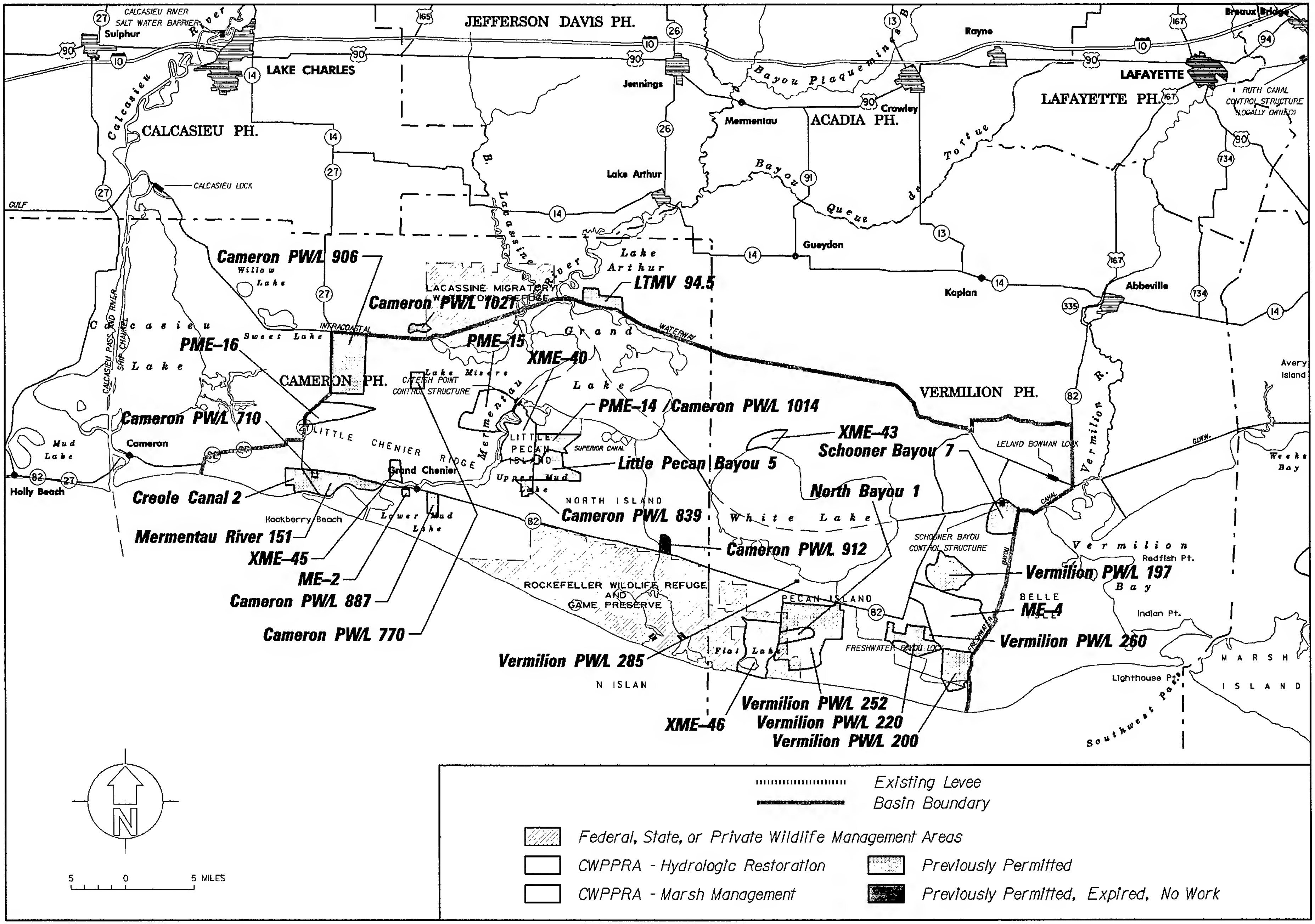


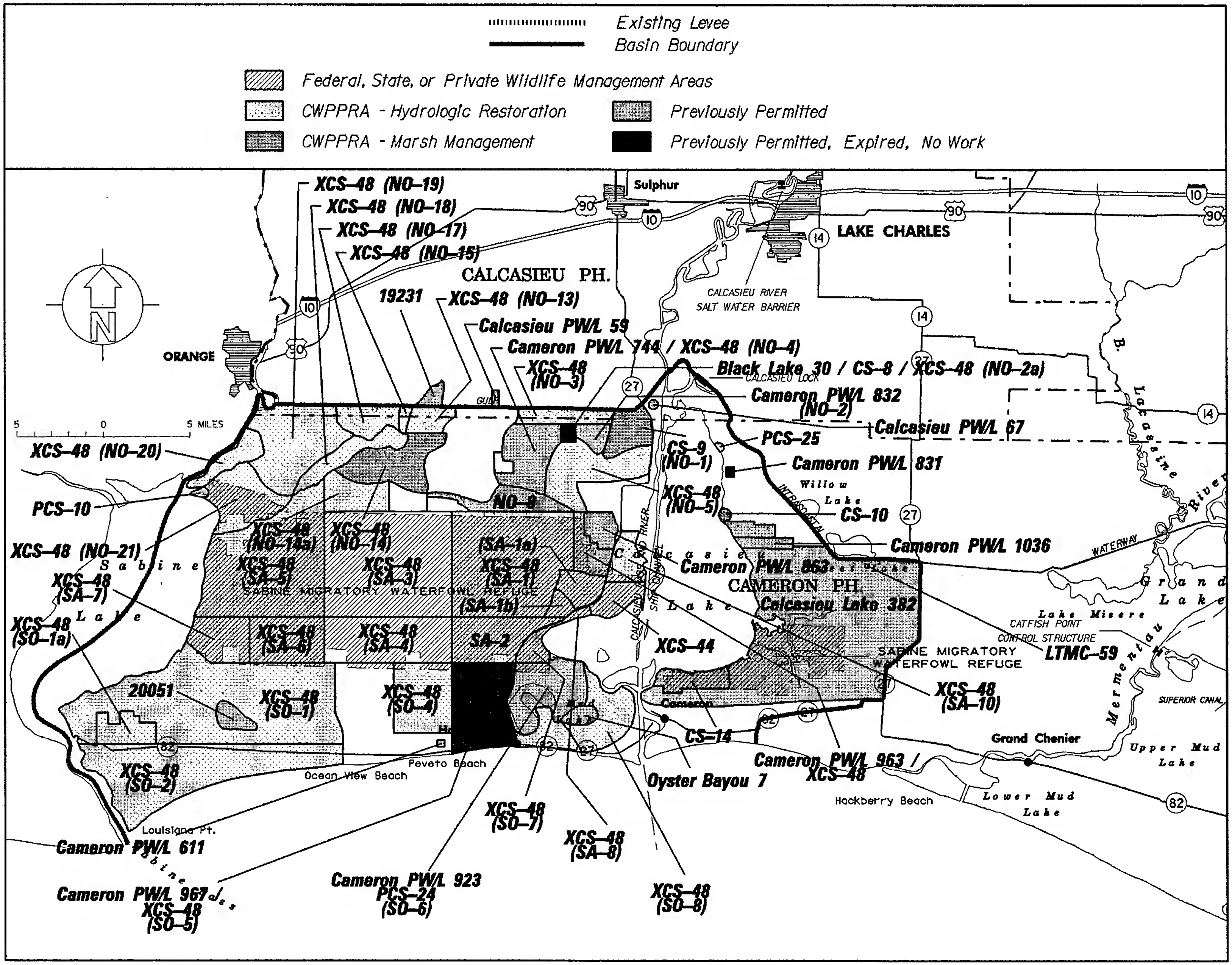
Terrebonne Basin (Basin No. 5)



Teche – Vermilion Basin (Basin No. 7)



Mermentau Basin (Basin No. 8)



Calcasieu – Sabine Basin (Basin No. 9)

6.0. *COORDINATION/PUBLIC INVOLVEMENT*

6.1. **Coordination**

1. December 1986.

Agreement between NOD, NRCS and Louisiana Department of Natural Resources (DNR) on need for marsh management EIS.

2. April 1986.

NOD, NRCS and DNR meet and discuss funding possibilities and work responsibilities preliminary to starting work on the draft programmatic marsh management EIS. NRCS is prepared to assume lead agency status but lacks the funds and man power to begin.

3. November 1987.

NOD, DNR, and NRCS personnel meet again. DNR announces funding agreement with USDI - Minerals Management Service (MMS) to do a study of marsh management as a candidate mitigatory effort for some of MMS's programs. Agreement on the MMS study being a good base from which to write the EIS. NOD declares its intention to assume lead agency status in the EIS process because of its permit involvement but acknowledges the desirability of NRCS participating formally as a cooperating agency.

4. May 1988 - December 1990

NOD participants as member of MMS/DNR marsh management study technical steering committee.

5. Summer 1988

NOD/NRCS attempt to formulate a working agreement for preparing the EIS. Effort deferred until MMS/DNR study completed.

6. July 1991

NOD begins work on EIS. Solicits comments on the MMS study from Federal and state agencies.

7. August 1991
NRCS again invited to participate as cooperating agency.

8. February 1992.

NRCS commits to role as cooperating agency.

9. February-June 1992

NRCS/NOD coordination meetings.

10. July-August 1992

EPA, FWS and NMFS accept NOD's invitation to join NOD and NRCS as cooperating agencies.

6.2. **Public Involvement**

1. February 1988.
* The Corps of Engineers, New Orleans District NOD and the USDA - Soil Conservation Service (NRCS) announced their intention to jointly prepare a Draft Programmatic Environmental Impact Statement (DPEIS) for Marsh Management in Coastal Louisiana in the February 10, 1988 edition of the Federal Register (Vol. 53, No. 27, page 3910).

* The NOD and NRCS announced by public notice and jointly sponsored two separate DPEIS public meetings identified as Scoping Workshops: February 23, 1988 - Jennings, Louisiana February 25, 1988 - New Orleans, Louisiana

The purpose of these meetings was to receive public input on marsh management. Written comments were accepted through March 11, 1988.

2. April 1988.

* NOD promulgates the DPEIS scoping document (letter dated April 18, 1988).

6.3. **Coordination With Cooperating Agencies**

* August 1993 - very early version of some draft chapters of PMMDEIS delivered to Coop agencies in advance of coordination meetings.

* Sept 1993 - coordination meeting, at which agencies were informed of NOD's funding constraints that necessitated temporarily suspending further work on the PMMEIS.

* April 1994 - NOD solicited references from cooperating agencies.

* June-August 1994 - NOD merges/tabulates all agency references and prepares its own listing of candidate

references and supplies both tabulations to the cooperating agencies.

* June 1995 - 50% Review version sent to cooperating agencies for review and comment.

* July 13, 1995 - coordination meeting to discuss comments on 50 % review version.

* January 1996 - extended comment period on D-PHMEIS for EPA and USFWS because of Federal budget problems and for LADNR because of transition from Gov. Edwards to Gov. Foster.

* February-March 1996 - LADNR still was unable to submit comments.

* June 6, 1996 - Met with EPA (Yvonne Vallette), NMFS (Rick Ruebsamen), NRCS (Marty Floyd) and USFWS (Ronnie Paille) in Baton Rouge to update them on the status of F-PHMEIS. Supplied them with comparison of draft and final documents, tables, and figures and answered questions. LADNR unable to attend.

* June 13-14, 1996- Made follow-up telephone calls to EPA, NMFS, NRCS and USFWS about thoughts since last-week's meeting. Received FAX of written follow-up comments from NRCS.

* June 20, 1996- Met LADNR (Darryl Clark and Greg Ducote) in Baton Rouge to update them on the status of F-PHMEIS. Previously supplied them with comparison of draft and final documents, tables, and figures and answered questions.

6.4. **Coordination With Public**

* June 1994 - Presentation of the PMMEIS concept/status report to the Gulf of Mexico Fishery Management Council

* August 1994 - Status update presented to the EPA Marsh Management Workshop, New Orleans LA

* August 1994 to Present - Respond to several telephone inquiries about status from Tulane Law Clinic and the LEU Sea Grant Program (Legal)

* June 1995 - Presentation of the PMMEIS concept/status report to the Gulf of Mexico Fishery Management Council

* October 1995 - Issuance of Draft PHMEIS

* October - December 1995 - Comments on Draft PHMEIS

* April 1996 - Called by Dr. Herke. Discussed his comments on the D-PHMEIS.

7.0. *PREPARERS*

LOUISIANA DEPARTMENT OF NATURAL RESOURCES- COASTAL RESTORATION DIVISION (LADNR)

Darryl Clark

Role: Cooperating Agency Representative- Recipient of 50% draft PHMEIS and portions of an early version of the draft F-PHMEIS
Discipline/Expertise: Biologist/Coastal Ecologist
Education: 1980 MS- Aquatic Ecology, USL
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Experience: 5 year coastal restoration work
9 years coastal regulatory work with LaDNR
* 5 - permitting
* 4 - wetland management proposal review, coordination, research

2 years teaching at USL

US ARMY CORPS OF ENGINEERS - NEW ORLEANS DISTRICT (NOD)

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Chris Brantley

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1957 BS- Botany, Brown University
Experience: 24 years environmental planning, marsh ecology with NOD

Bill Klein
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Experience: 2.5 years Biologist, Environmental branch, NOD
2 Years College Professor

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Role: Author/Contributor
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3 years USAE Waterways Experiment Station, Vicksburg, MS

US DEPARTMENT OF AGRICULTURE - NATURAL RESOURCE AND CONSERVATION SERVICE (NRCS)

Martin D. Floyd
Role: Cooperating Agency Representative, Recipient/Commentor on 50 % draft PHMEIS and portions of an early version of the draft F-PHMEIS
Discipline/Expertise: Certified Louisiana Environmental Professional
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1979 BS- Biology, University of Arkansas (Little Rock)
1972 Associate- Applied Science, Hocking Technical College
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Rick Hartman

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1978 BS- General Biology, Auburn University
Experience: 6 years NMFS
2 years Research Assoc Louisiana Geological Survey
4 years Research Associate - LSU

US ENVIRONMENTAL PROTECTION AGENCY (EPA)

Yvonne M. Vallette

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Recipient/Commentor 50 % draft PHMEIS and
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4 years Corps of Engineers (Vicksburg, MS)
2 years US Fish and Wildlife Service (Louisiana)

US FISH AND WILDLIFE SERVICE (FWS)

Ronald F. Paille

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Discipline/Expertise: Coastal Ecology/Coastal Fisheries

Education: 1980 MS- Marine Sciences, Louisiana State University

1977 BS- Zoology, Louisiana State University

Experience: 9 years US Fish & Wildlife Service

* 7 years Ecological Services (Lafayette, LA
* 2 years Refuge biologist (Sabine Refuge, LA)

4 years biologist Little Pecan Island Management Area

3 years Louisiana State University- fishery/marsh management research associate

8.0. *LITERATURE CITED and OTHER REFERENCES*

Literature Citations (Candidates) for the Programmatic Marsh Management EIS. Following each citation is a list of the Federal cooperating agencies which submitted the particular reference for inclusion in the PEIS: U.S. Army Corps of Engineers (COE), Environmental Protection Agency (EPA), National Marine Fisheries Service (NMFS), Natural Resource Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS). Literature cited in the text is indicated by a "*".

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9.0. *APPENDIXES*

A - Louisiana Coastal Zone Marsh Types
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A- Louisiana Coastal Zone Marsh Types

NOTE: Literature citations are presented in
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Fresh Marsh

Plant Species

Throughout coastal Louisiana, rushes, maidencane and bulltongue (Eleocharis spp., Panicum hemitomon and/or Sagittaria falcata, respectively) are two to three times more prevalent than any of the nearly 90 other fresh marsh plant species (Chabreck 1972). Alligatorweed (Alternanthera philoxeroides) and salt meadow grass (Spartina patens) were prevalent co-associates (Chabreck 1972). Forty-nine species were unique to the fresh marsh type, accounting for less than 10 % of the marsh type species composition (Chabreck 1972). Twenty-one species occurred as components of the intermediate and brackish marsh types but only four species (spike grass, Distichlis spicata; black rush, Juncus roemerianus; loosestrife, Lythrum lineare; and salt meadow grass) occurred in all four marsh types (Chabreck 1972). Loosestrife was a minor component in all four marsh types (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

Soil Types and Chemistries

Brupbacher et. al. (1973) reported that fresh marsh occurred on two types of mineral (less than 16 % organic matter) soils and two types of organic soils (greater than 16 % organic matter). Organic matter content ranged from about two percent (mineral - clay) to 89 % (organic-mucks and clays) (Brupbacher et. al., 1973). From his chemical assays, it appears that the more organic mucks and peats are discernibly different from the other organic soil as well as the two mineral soils.

Chabreck (1972) reported the same trend except in the Calcasieu-Sabine basin where the average and range of organic material suggest the existence of between as well as

within basin differences. Small sample sizes preclude more definitive statements.

Assays of chemical species of fresh marsh soils revealed repeating trends with much overlap but marked differences between the two most disparate soil types (mineral clays and the organic mucks and peats clays) (Brupbacher et. al., 1973). Chabreck (1972) recorded similar trends of the same magnitudes.

Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports.

However, some species specific information can be gleaned by referring to Nyman and Dulane (1991); Pezeshki et al, (1987a); and Mendelssohn and McKee (1987).

Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to in excess of six ppt. Basin salinity averages, their variation and their range each spanned an order of magnitude. Differences between basins were suggested more so than any suggestion of regional differences.

The salinity regime in the Pontchartrain basin seemed to exhibit generally higher levels both on average and as peaks than any of the other Delta basins.

No single comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972). What does exist is salinity tolerance profiles for many marsh plants. [See Mendelssohn and McKee (1987) and Pezeshki et al. (1987b, 1991) for some species specific information].

Intermediate Marsh

Plant Species

Salt meadow grass was an order of magnitude more prevalent than any other plant species (Chabreck 1972). Bull tongue, water hissop (<u>Bacopa monnieri</u>), reed grass (<u>Phragmites communis</u>) and jointgrass (<u>Paspalum vaginatum</u>) were about

twice as prevalent as any of the 49 other plant species that comprise this marsh type (Chabreck 1972). Three species ccurred as a component of only the intermediate marsh type (Chabreck 1972). Forty-four species occurred in fresh marshes (Chabreck 1972). Thirty-one species occurred as components of the brackish marsh type, of which only eight occurred as components of the saline marsh type (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

Soil Types and Chemistries

Brupbacher et. al. (1973) did not report results for this marsh type.

Chabreck (1972) encountered intermediate marsh in all but the Atchafalya basin. Intermediate marsh occurred on both mineral and organic soils. Organic matter content ranged from less than one percent to nearly 83 %. Only in the Barataria basin did this marsh type tend to occur as much or more on mineral soils than on organic soils. The averages and ranges of organic matter content suggest the existence of between as well as within basin differences. Small sample sizes preclude more definitive statements.

Chabreck's (1972) assays of chemical species from intermediate marshes are not definitive relative to the potential for within basin differences because of extremely small sample sizes. Suggestions of between basin differences may also be artifacts of small sample sizes.

Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. However, some species specific information can be gleaned by referring to Pezeshki et al, (1987a).

4.5.2.4. Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 10 ppt. Basin salinity averages were of the same order of magnitude. Only the recorded ranges differed by an order of magnitude. Differences between basins were suggested more so than the possible existence of regional differences but those trends may be an artifact of small sample sizes. The salinity regime in the Barataria basin seemed to exhibit generally higher levels both on average and as peaks than any of the other Delta basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972). [See Pezeshki et al. (1987b, 1991) for some species specific information].

Brackish Marsh

Plant Species

Salt meadow grass was four times more prevalent than spike grass but both were an order of magnitude more prevalent than any of the other 38 species that comprise this marsh type (Chabreck 1972). Of those 38 species, four species {oyster grass (S. alterniflora), widgeongrass (Ruppia maritima), three square sedge (Scirpus onleyi), and black rush} are the most prevalent (Chabreck 1972). Five species occurred as a component of only the brackish marsh type (Chabreck 1972). Only three species occurred as components of only the brackish and saline marsh types and all three occur infrequently (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

Soil Types and Chemistries

Brupbacher et. al. (1973) reported that brackish marsh

occurred on both mineral soils and both organic soils. Organic matter content ranged from about two percent (mineral - clay) to 85 % (organic-mucks and clays) (Brupbacher et. al., 1973). From his chemical assays, it appears that his soils encompass consistent chemical gradients, the end points of which are decidedly different.

Chabreck (1972) encountered brackish marsh in all but the Atchafalya basin. Brackish marsh occurred on both mineral and organic soils. Organic matter content ranged from less than two percent to nearly 86 %. The data suggest that the organic matter content of Chenier brackish marshes were more similar to each other and measurably lower than Delta brackish marshes.

Chabreck's (1972) assays of chemical species from brackish marshes tend to reinforce and expand the suggestion of difference between brackish marshes that occur in the various basins, even with the same region.

Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz 1995, Sasser 1995). If that information does exist, it is probably in the form of unpublished studies or reports. However, some species specific information can be gleaned by referring to Burdick et al (1989) and Nyman and Delaune (1991).

Salinity

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 29 ppt. Basin salinity averages spanned an order of magnitude. The higher the average salinity the less variations in salinity there appeared to be. The Vermilion-Teche, Mermentau and Calcasieu-Sabine basins evidenced lower average salinities with wider salinity variations than did the Pontchartrain and Breton basins. Those trends are suggestive of a salinity gradient that increases from west to east across the coastal zone but with a tendency for greater swings in salinity in the western basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972). [See Koch and Mendelssohn (1989), Mendelssohn and McKee (1987) and

Pezeshki et al. (1987b, 1991) for some species specific information].

Saline Marsh

Plant Species

Oyster grass was about five times more prevalent than the two next most abundant species (spike grass and black rush) (Chabreck 1972). Each of those three species was an order of magnitude more abundant than any of the 14 other plant species that comprise this marsh type (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

Soil Types and Chemistries

Brupbacher et. al. (1973) reported that the saline marsh type occurred on mineral and both organic soils. Organic matter content ranged from about four percent (mineral - clay) to 77 % (organic - mucks and clays) (Brupbacher et. al., 1973). From his chemical assays, it appears that his soils encompass consistent chemical gradients, the end points of which are decidedly different.

Chabreck (1972) encountered saline marsh in all but the emerging birds-foot delta and the Atchafalya basin. Saline marsh occurred on both mineral and organic soils. Organic matter content ranged from less than one-half percent to more than 66 %. The very limited data from the Chenier basins and the Teche-Vermilion must be treated with great caution because of their extremely small sample sizes. They offer no insight into potential within basin differences. However, as a group compared to the remaining eastern Delta basins, measurable differences have been recorded suggesting there may be real differences in the composition of the soils.

Chabreck's (1972) assays of chemical species from saline marshes tend to reinforce and expand the suggestion of difference between saline marshes that occur in the various basins.

Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. However, some species specific information can be gleaned by referring to Mendelssohm and McKee (1987, 1989) and Nyman and Delaune (1991).

Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 52 ppt. Differences between Delta basins were suggested more so than the possible existence of regional differences but those trends may be artifact of small sample sizes.

The salinities recorded in the Breton basin were the highest on average and exhibited peaks nearly double those in any other basin.

Basin salinity averages spanned an order of magnitude. The data suggest that the higher the average salinity the less variation in salinity occurred. The Vermilion-Teche, Mermentau and Calcasieu-Sabine basins evidenced lower average salinities with wider salinity variations than did the Pontchartrain and Breton basins. Those trends are suggestive of a salinity gradient that increases from west to east across the costal zone but with a tendency for greater swings in salinity in the western basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972). [See Mendelssohn and McKee (1987) and Webb (1983) for some species specific information].

Synthesis

A Louisiana fresh, intermediate, brackish or saline marsh in one part of the coastal zone can look and be structurally quite dissimilar from the same "type" of marsh in another part of the coastal zone. The fresh "floating" marshes in Terrebonne Parish and the fresh "hard bottom" marshes in Cameron Parish are excellent examples. Thus, looking at one or two attributes of a marsh type may lead one to conclude that a type can occur over a wide range of environmental

conditions.

To an extent that is true. However, each type can also be thought of as a collection of graded biological responses to patterns of interactions between several influential soil, hydrologic, chemical and biotic attributes. Therefore, each manifestation of a Louisiana coastal marsh type could be a fairly localized, site specific, specialized response to a unique set of interacting factors. As examples, Chabreck (1970) noted differences between soils, physico-chemical parameters and plant communities on active versus inactive delta formations that he reemphasized in 1994 (Chabreck 1994). Also, Nyman, Delaune and Patrick (1990) reported differences in wetland soil formation processes on active and inactive delta sites relative to mineral and organic matter relationships. Thus, management plans that encompass one or more marsh types, and are formulated from generalized experiences (that span rather than focus on very localized scales), could produce vegetative as well as dependent animal responses below expectations.

B - Management Structures: A overview of the design, impacts and effects of several water control structures used for MM/HR

NOTE: Literature citations are presented in
8.0. *LITERATURE CITED and OTHER REFERENCES* of the F-PHMEIS

There exists an impressive arsenal of structures and operational options managers can use to affect the hydrologically-influenced attributes that influence the growth and vigor of marsh vegetation and mash-dependent animal species (Broussard, Undated). Managers can affect where water comes from or goes, how quickly or slowly it moves over and through the marsh, how deep or shallow water levels get over vegetated marsh surfaces, marsh soil profile and in ponds, and what it carries entering or leaving a marsh (Broussard, Undated).

Management structures typically effect a suite of hydrologically-influenced attributes, some by design some unavoidably. However, the best designed and operated application of management structures will be maximally effective only within a portion of the environmental variation that controls the viability of Louisiana's coastal marshes. Seasonal rainfall shortages or excesses, tropical weather systems and subsidence are factors some individual managers are powerless to slow, stop or reverse but significantly effect how much or how little their management efforts can be expected to achieve. Thus, the hydrologic effects of the structures selected for a given management effort seldom correspond perfectly with management needs. The difference can be the basis for the manager contemplating what, if any, secondary interests can be addressed to what degree with what, if any, additional effort. The difference can also have associated social and economic implications as well as other biological consequences.

Spicer, Clark and deMond (1986) and Broussard (Undated) discuss engineering and construction details of several commonly used water control structures for managing marshes. Information about some of the environmental design considerations (Spicer, Clark and deMond 1986) and water management schedules (Broussard, Undated) associated with several commonly used structures is also available. Broussard (Undated) also briefly discusses some of the structure variations (Broussard, Undated - Chapter 9: New Engineering Techniques). Rogers, Herke and Knudsen (1987) focus on some of the comparative hydrologic and biological effects of two structures.

B.1. Plugs/Levees

Levees and plugs serve nearly identical hydrologic

functions, the principal one being to create an impermeable barrier. By perceiving a plug as a very short levee or a piece of a levee, then what follows could apply to both plugs and levees.

Constructed of wood, metal sheet pile, shell, or some combination thereof, plugs are designed to permanently prevent the exchange of water (Broussard, Undated). The crest of these structures is typically at or above marsh level. They are used independently or in conjunction with other structures.

Once installed, a plug will influence water levels and other attributes without any need for further adjustment (Broussard, Undated). Provided water levels don't overtop the structure, the degree of influence is constant and absolute.

The desired impact of a plug on the hydrology of a managed area is to create an impermeable barrier between the managed area and the surrounding marsh system such that the hydrologically-driven rhythms, dynamics and chemistry of the managed area can be controlled by actions taken where the managed area communicates with the surrounding marsh system.

The desired management effects are to: 1) create the opportunity to manage at a distant location; 2) preclude the intrusion of unwanted outside influences at a particular location; 3) deflect hydrologically-driven influences to another area; and/or, 4) serve to discourage entry into managed areas.

Often unintended but associated biological effects of management include: 1) an instantaneous reduction of estuarine fisheries access (due to the physical presence of the structure); 2) use by nontargeted bird species and animal species during periods of irregular water levels (e.g., refugia during high water events); and, 3) congregate fish. Reduction of these effects can be the subject of mitigation.

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduced, possibly even eliminate, access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives, and/or 2) congregate fishermen, which is a commonly known effect. Reduction of these effects can be the subject of mitigation.

Very infrequently is a plug used as the only water control structure for management any more. The norm is to use plugs

in conjunction with other kinds of water control structures.

The biological effects and management effectiveness of plugs, when used in combination with other structures, have not been independently or comprehensively studied and documented quantitatively. As such, NOD concludes that effects and effectiveness have been presumed largely by extension of our understanding of plugs when used singularly.

The contribution plugs make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a plug when used in combination plans probably arises more from the management flexibility the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

B.2. Rock Weirs

Constructed of large-sized rock, these weirs are designed to dampen the rate of and volume of water exchanged between managed and unmanaged areas much like a fixed-crest weir (Broussard, Undated). However, water moves through the entire profile of the structure via the spaces between rocks. The top of these structures can be above or below marsh level, but typically is set at or just below marsh level (Broussard, Undated).

Once installed, a rock weir influences water levels and other hydrologically influenced attributes without any need for further adjustment. However, the degree of influence is not constant because water is continuously exchanged throughout the water column between the managed and unmanaged areas.

The desired impact of a rock weir on the hydrology of a managed area is to slow the rate of and reduce the volume of water exchanged between managed marsh and the surrounding marshes. In a sense it's designed to leak in both directions, or act as a filter. Thus, the rhythms, dynamics and chemistry of the surrounding marshes area will be "filtered" through the rock weir but will still be expressed, although in a diminished manner, primarily in the portions of the managed area nearer the structure. Stated more formally, rock weirs can be used to: 1) dampen the intrusion of unwanted outside influences at a particular location (e.g., primarily the erosive effect of water movement, secondarily salinity); 2) allow for a limited introduction of desirable hydrologically-influenced attributes (e.g., nutrient, mineral and detrital exchange);

and/or, 3) partially deflect hydrologically-driven influences to another area.

The foremost desired management effect is to foster the movement of fisheries between the managed and unmanaged areas (Rogers 1989). Secondary desired management effects include: 1) improve the growth conditions for submerged aquatic vegetation (by reducing the amounts of suspended materials and salinity introduced into the managed area); 2) preserve stands of submerged aquatic vegetation (by forestalling the onset of the stresses induced when ponds drain by prolonging the time it takes for ponds to rain or fill in response to winds or tidal action); 3) serve to discourage human entry into managed areas; and/or, 4) possibly retain enough water in the managed area to facilitate recreational and commercial activities.

Often unintended but associated biological effects of management include: 1) an instantaneous reduction of estuarine fisheries access (due to the physical presence of the structure); 2) use by nontargeted bird and animal species during periods of irregular water levels (e.g., refugia during high water events); and/or, 3) congregate fish; 3) progressively isolate managed area (because spaces between rocks become clogged).

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduce, possibly eliminate, access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations are feasible design modifications relative to the management objectives; 2) congregate fishermen; and/or 3) block access by the public to managed areas.

Rock weirs have not been used extensively. Most marsh soils (especially in the Delta Region) don't readily support their great weight (Broussard, Undated), adding appreciably to maintenance costs. Generally, rock weirs have been used as the only water control structure. There seems to be a great potential to investigate where they have utility, and what relationship(s) their may be between marsh elevation changes, changing water levels, and the hydrologic impacts. Apparently, the effects and effectiveness of rock weirs have not been adequately documented but, of necessity, presumed based largely on professional insights driven by the results of very limited studies (eg, Rogers 1989) and fewer field applications. As such, NOD concludes that applications, effects and effectiveness should be presumed with great caution, but because they pass water throughout the water column, could be roughly compared with slotted weirs, at least in that simple context.

The contribution rock weirs could make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a rock weirs probably arises more from the reduced hydrologic and fisheries impacts that are associated with those structures. Projections of "futures" conditions will reflect this assumption.

B.3. Fixed-crest weir

Fixed-crest weirs, essentially a low-level dam set at an unadjustable elevation (historically six inches below marsh level), are strategically placed in surface waterways or embankments (Broussard, Undated). Once installed, the weir will influence water levels and other attributes without any need for further adjustment (Broussard, Undated). However, the degree of influence is not necessarily constant. So long as water levels remain above the crest elevation (or the area is not otherwise hydrologically isolated), the managed area's rhythms and dynamics would be nearly identical with those in the surrounding marsh. Once water levels fall below the crest, the managed area shows progressively less to very little linkage with the physical and biological rhythms, dynamics and chemistry of the surrounding marsh, especially if the area is semi-impounded (eg, Burleigh, 1966; Herke 1971; Herke, Knudsen, Knudsen, and Rogers, 1987, 1992; Hoese et al, 1990; Hoese and Konikoff, 1995; Rogers and Rogers, 1990).

The desired impacts of a fixed-crest weir on the hydrology of a managed area are to retain a minimum amount of water in ponds even when water levels outside the managed area are lower or rise suddenly because of vessel passage, reduce surface water salinities, reduce water exchange velocities and reduce suspended sediments in the water column (Broussard, Undated).

The desired management effects are to: 1) facilitate the growth of submerged aquatic vegetation (through the reduction of suspended materials and salinity reduction)-eg, Joanen and Glasgow 1965; 2) preserve stands of submerged aquatic vegetation (by precluding the stress induced as ponds drain and fill in response to winds or tidal action); 3) retain enough water in the managed area to facilitate recreational and commercial activities (eg, Chabreck 1968); and in some cases, 4) restore to some degree historically fresher conditions.

Often unintended but associated biological effects of management include: 1) an immediate reduction of estuarine fisheries access (due to the physical presence of the

structure- eg, Herke 1971); 2) slow to materialize but eventually measurable shifts to a fresher fisheries community (again due to the isolating effect of the structure); 3) higher use by nontargeted bird species during periods of low or no water in surrounding marshes (eg, Chabreck 1971, 1976; Breininger and Smith, 1990); 4) possibly even a slow to materialize but eventually measurable shift to a more flood tolerant emergent marsh plant species community (eg, Clark 1989a); and, 5) congregate fish.

Sometimes unintended but associated and unavoidable social and economic effects are to: 1) immediately reduced access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives, and/or 2) congregate fishermen, which is a commonly known effect. Reduction of these effects can be the subject of mitigation.

Very infrequently is a fixed-crest weir used as the only water control structure for management any more. The norm is to use fixed-crest weirs in conjunction with other kinds of water control structures.

A biological effect that is being investigated is what effect fixed-crest weirs, usually in combination with other structures, have on sediment dynamics in particular, but marsh floor elevations in general, and, thus, the relationship between marsh elevation changes and changing water levels.

The effectiveness of fixed-crest weirs at achieving management goals when used singularly is variable.

The biological effects of and management effectiveness of fixed-crest weirs (to include boat bays), when used in combination with other structures, have not been quantitatively studied and documented. As such, NOD concludes that effects and effectiveness have been presumed largely by extension of our understanding of weirs when used singularly.

The total contribution fixed-crest weirs make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a fixed-crest weir used in combination plans probably arises more from the management flexibility the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

B.4. Verticle-slotted weir

Once installed, a vertical-slotted weir will influence water levels and other attributes without any need for further adjustment (Broussard, Undated; Rogers, Herke and Knudsen, 1987). However, the degree of influence is not constant. So long as water levels remain above the crest elevation, the managed area exhibits rhythms, dynamics and water chemistries nearly identical with those in the surrounding marsh. Once water levels fall below the crest, however, the rhythms and dynamics of the managed area still exhibit the rhythms and dynamics of the surrounding marsh but to a diminished degree and slightly out of phase (Rogers, Herke and Knudsen, 1987).

The desired impacts of a verticle-slotted weir on the hydrology of a managed area are to: 1) increase the linkage between the managed and unmanaged marshes (Rogers, Herke and Knudsen 1987); 2) retard but not necessarily prevent the evacuation of water from ponds as part of physical rhythms and dynamics of the marsh surrounding marsh system (Op. Cite.); 3) reduce water exchange velocities; and, 4) reduce suspended sediments in the water column (Broussard, Undated).

The overriding management effect desired is to facilitate and promote the freer exchange of fisheries species into and out of managed areas (by eliminating the truncation of the rhythms and dynamics of the marsh system caused by the solid wall of a traditional fixed-crest weir). In a test situation, a 6" verticle slotted, fixed-crest weir did have significantly less adverse effect on fisheries (Rogers, Herke and Knudsen 1987). Although unquantified, a slotted weir structure should be somewhat less effective (than a fixed-crest weir) at: 1) fostering the growth of submerged aquatic vegetation (through suspended materials reductions); 2) preserving stands of submerged aquatic vegetation (by reducing the potential stress associated with ponds draining and filling in response to winds or tidal action) barring prolonged periods of low water in the surrounding marshes; and, 3) retaining enough water in the managed area to facilitate recreational and commercial activities.

Often unintended but associated effects of management with vertical-slotted weirs include: 1) a fairly quickly and measurable suppression of fisheries (still related to the constriction imposed by the structure), but less than associated with a fixed-crest weir (Rogers 1989) ; 2) a salinity response characterized by a fairly quickly and measurable reduction of salinity variation accompanied, however, by a slight increase in average salinity, that virtually disappear when water levels overtop the structure

and/or seasons move from winter into summer (unexplained); and, 3) no measurable effect on water temperatures. No data are available directly linking use by nontargeted bird species during periods of low or no water in surrounding marshes or how emergent vegetative species respond in either the short or long-term to the independent hydrologic effects of slotted-weirs.

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduce access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives; and/or, 2) congregate fishermen.

Very infrequently is a vertical-slotted fixed-crest weir used as the only water control structure for management any more. The norm is to use one or more in combination with other kinds of water control structures when their use won't compromise the overall management objective.

The effectiveness of vertical-slotted weirs at achieving some management goals when used singularly is based solely on the work by Rogers, Herke and Knudsen (1987).

The biological effects of and management effectiveness of fixed-crest weirs (to include boat bays), when used in combination with other structures, have not been quantitatively studied and documented. The range of biological effects associated with using verticle-slotted fixed crest weirs have yet to be quantified. What effect they have singularly, in combination with other structures, on sediment dynamics in particular, but marsh floor elevations in general, and, thus, the relationship between marsh elevation changes and changing water levels, remain fertile areas for investigation. As such, NOD concludes that effects and effectiveness have been presumed largely by professional insight driven extensions of our understanding of weirs when used singularly.

The contribution verticle-slotted weirs make to reducing social and economic effects when used singularly or in combination with other types of structures is unknown, but probably isn't much different than a fixed-crest weir. However, any reduction of adverse social and economic effects related to the use of a verticle-slotted weirs used in combination plans probably arises as much from the reductions of unavoidable adverse effects on estuarine, migratory fisheries species as from the management flexibility the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

B.5. Variable-crest weir, mated with flap-gated culvert(s)

The variable-crest weir was adapted to management of Louisiana marshes by NRCS during the late 1970's.

A variable crest weir is a dam whose elevation can be periodically raised or lowered at the discretion of the manager so that the degree of control on water levels and other hydrologically-driven attributes can be maintained at some relatively constant level regardless of the environmental variation. The lowest weir crest elevation is often lower than most pond substrates in the managed area, allowing the exposure of as much pond substrate as possible (Broussard, Undated).

Upon installation, or as a retrofit, the variable-crest weir can be mated with a flap-gated culvert. The culvert can have one flap-gated end that discharges to the surrounding marsh, or it can have flap-gates on both ends, to provide maximum management capability with just one structure (Broussard, Undated). The resultant structure can be operated as a fixed-crest weir {by setting the weir crest at the appropriate level and locking open the flap(s)} or it can be configured to only discharge water from the managed area (by unlocking the outside flap gate, locking open the inside flap gate and lowering the weir crest), thus lowering water levels in the managed area to levels lower than in the surrounding marsh.

If configured in a fixed-crest mode, the degree of influence is not constant and changes in proportion to the amount of variation in the environment. More typically, the structure is configured to operate according to a management-related schedule. When operated in this mode, the degree of influence can be kept constant or adjusted in any proportion to the amount of environmental variation wishes to be communicated to and expressed within the managed area, to include intentionally isolating the managed area from the dynamics, rhythms and chemistry of the surrounding marsh.

The desired impacts of a variable-crest weir fitted with a flap-gated culvert on the hydrology of a managed area are the capability, at any time of any year, to: 1) fairly precisely manipulate (rather than just dampen) water levels (quantity); 2) precisely control flooding duration; and, 3) affect the water quality by configuring the structure to admit as much or as little water from the surrounding marsh. Additional effects are: 1) facilitating an even more extensive and vigorous growth of submerged aquatic vegetation (through the firming of exposed substrates and tighter salinity and water level control); 2) affecting a suite of life requisite factors by artificially creating and

sustaining a relationship between water levels and exposable marsh substrates (that would otherwise be inundated) conducive to the growth of emergent marsh plant species (through scheduled water level reductions typically once every three years); 3) the ability to allow fishery ingress and egress for limited periods without completely compromising the overall management goal(s) {by briefly locking open the flap gate(s) and lowering the weir crest for ingress, and lowering the crest and unlocking the flap-gate(s)} for egress; and, 4) the flexibility to address subordinate interests (by creating the potential to modify the composition of the marsh plant community).

In addition to the unintended but associated biological effects, during prolonged periods of generally low fresher water availability (typically July through October), some managers must decide whether the risks of introducing only enough saltier water from the surrounding marsh into the managed area (to prevent desiccation of the vegetation and drying of the substrate) are greater than waiting for a storm to introduce fresher water.

The unintended but associated and unavoidable social and economic effects of managing with a variable-crested weir mated with a flap-gate are very similar to those enumerated for a fixed-crest and verticle-slotted weir. Notably, fishermen generally have learned that these structures can be fished easily and very efficiently at certain times of the year. A few fishermen may apply that knowledge in the extreme by fishing with nets very near to or affixing nets to the outside end of a culvert and configuring the culvert (and weir) to free flow, usually contrary to prescribed management settings. Left uncorrected, or if the structure was damaged and the situation can't be corrected by the manager in time, the management effort could be compromised as well as creating the potential to damage the targeted marsh.

Because of the greater management potentialities created, managers are opting more often to use a variable-crest weir mated with a culvert and flap-gate(s) in hydrologically discrete areas. Other structures may well be used in the management effort but largely in a supporting role. The capability to induce vegetation to grow on exposable substrates, in combination with the possibility that the growth and vigor of the native emergent vegetation is appreciably increased, provides the basis for the assertion that this form of management can reverse marsh losses.

The contribution variable-crest weirs mated with a culvert and flap-gate(s) make to reducing social and economic effects when used singularly or in combination with other

types of structures is unknown. There is a basis to argue that they heighten the potential for conflict between the landowners/leaseholders and components of the general public. However, any reduction of adverse social and economic effects the use of such management structures may cause when used in combination plans probably arises more from the impact reduction potentials the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

The biological effects of and effectiveness of variable-crest weirs mated with a culvert and flap-gate(s) have yet to be generally proven, are being monitored in field applications (Fina LaTerre, Rockefeller), are apparently presumed by proponents to be highly effective (largely based upon the high degree of management flexibility the use of such structures gives the manager and the notion that some degree of management will always be possible with such a structure), but questioned by those who's interests are adversely effected (NMFS, users of marsh dependent animal species). Many aspects remain to be quantified but the pivotal biological question is what effect(s) such structures have singularly, or in combination with other structures, on the degree and rate marsh soil losses can be slowed, stopped or reversed (such that marsh soils and elevations can be recreated and revegetated after being eroded). The pertinent social and economic questions are whether intensively managed areas will prolong and invigorate or hasten the decline of a struggling commercial fishing industry. These have been and remain fertile areas for investigation and are the focal point of the social controversy surrounding HM.

NOD realizes that management undertaken principally with variable-crest weirs mated with a culvert and flap-gate(s) can be an option to other structure choices for management. The effects and effectiveness of such structures remain to be convincingly and comprehensively demonstrated.

C - NOD's Permit Data Base

This Appendix consists of two parts.

C.1. consists of the raw and complied data tables, from which the narratives were derived.

C.2. consists of the figures, which are based upon the data presented in Part 2.

C.1.: Raw and complied data tables

Key to Tables

Reference Tables 10, 12 and 15:
Bold Face = Monitoring Required
Bold Face and Underlined = Monitoring Submitted

NOTE: "Implemented" plan = initiated, completed and/or implementable plans

PURPOSE

WF - waterfowl/furbearers (targeted wildlife)
MR - reduce marsh deterioration/marsh restoration
MA - mariculture related activities
RE - research
FB - fur bearers

STATUS

Uppercase = Confirmed
Lowercase = Assumed

C = complete
P = parts installed
E = expired
NE = not expired
NW = no work

C/PI/I Projects = Completed/Partially Implemented/Implementable

Table C-1: Permits- Pontchartrain Basin (Basin 1)

PERMIT NUMBER	APPLICANT	CALENDA YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORIN	STATUS	ADJUSTE ACS ADD	SUM ADJ. ACS/YR	WATER MGT	Comment
		77		1		0	0				0	0		
		78		1		0	0				0	0		
		79		1		0	0				0	0		
		80		1		0	0				0	0		
St Bernard Ph w/l 33	St. Bernard Ph	81	81-01-21	1	B/S	3,080	3080	WF,MR	R	NW,E	0	0	A	
		82		1		0	0				0	0		
Lake Borgne Canal 5	St. Bernard Ph	83	83-10-03	1	B	2,762	2762	WF,MR	NR	NW,E	0		A	
Lake Borgne Canal 6	St. Bernard Ph	84	84-07-03	1	B	4,200	4200	WF,MR	NR	p,E	4200	4200	A	not functional
		85		1		0	0				0	0		
		86		1		0	0				0	0		
St Bernard Ph w/l 69	Biloxi Marsh Lands	87	87-04-16	1	S	834	834	WF,FB	R/NS	p,NE	834	834	A	not functional
St Charles Ph w/l 156A	St. Charles Land	88	88-05-26	1	I/B	12,640	12640	MR,WF	R/S	C	12640	12640	A	
		89		1		0	0				0	0		
		90		1		0	0				0	0		
		91		1		0	0				0	0		
		92		1		0	0				0	0		
IWW-NO to Mobile 65	Chefco	93	93-04-05	1	B	13,974	13974	WF,MR	R/S	p,NE	13974	13974	A	see CWPPRA (PO-15)
		94		1		0	0					0		
		95												
				SUMS		37490	37490				31648	31648		
6,248	Avg Acs/permitted plan in study are (N=6)	7,912	Avg Acs/"implemented" plan in study area (N=4)			N=6	N=6				N=4	N=4		

Table C-2: Permits- Breton Basin (Basin 2)

Table C-2: Permits- Breton Basin (Basin 2)

PERMIT NUMBER	APPLICANT	CALENDA YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORIN	STATUS	ADJUSTE ACS ADD	SUM ADJ. ACS/YR	WATER MGT	Comment
		77		2		0	0				0	0		
		78		2		0	0				0	0		
		79		2		0	0				0	0		
		80		2		0	0				0	0		
		81		2		0	0				0	0		
Plaq Ph w/l 282	Delacroix Corp	82	82-10-01	2	B	2,260	2260	WF,MR	NR	p,E	2260	2260	A	
St Bernard Ph w/l 48	St. Bernard Ph	83	83-05-13	2	B	3,080	11312	WF,MR	NR	nw,E	0	0	A	
Caernarvon Canal 1	St. Bernard Ph		83-09-30	2	B	2,960	1	WF,MR	NR	nw,E	0		A	
Bayou Mandeville 2	St. Bernard Ph		83-09-30	2	B	5,272		WF,MR	NR	nw,E	0		A	
		84		2		0	0				0	0		
		85		2							0	0		
		86		2		0	0				0	0		
		87		2		0	0				0	0		
		88		2		0	0				0	0		
		89		2		0	0				0	0		
		90		2		0	0				0	0		
		91		2		0	0				0	0		
		92		2		0	0				0	0		
		93		2		0	0				0	0		
		94		2		0	0				0	0		
		95												
				SUMS		13,572	13,572				2,260	2,260		
3,393	Avg Acs/permitted plan in study area (N=4)	2,260	Avg Acs/"implemented" plan in study area (N=l)			N=4	N=4				N=1	N=1		

Table C-3: Permits- Barataria Basin (Basin 4)

PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORIN	STATUS	ADJUSTE ACS ADD	SUM ADJ. ACS/YR	WATER MGT	Comment
		77		4		0	0				0	0		
		78		4		0	0				0	0		
		79		4		0	0				0	0		
		80		4		0	0				0	0		
Barataria B WW 226	James Webb Est.	81	81-09-25	4	B	1,190	1190	WF,MR	NR	nw,E	0	0	P	
		82		4		0	0				0	0		
Lafourche Ph w/l 480	Louis Cheramie	83	83-04-27	4	B/S	2,950	2950	MR		c	2950	2950	A	Partially abandoned
Lafourche Ph w/l 547	LL&E	84	84-10-19	4	B/S	3,573	61530	WF,MR	R	nw,E	0	57957	A	
Lafourche Ph w/l 517	Lafourche Realty		84-10-05	4	S	12,300		WF,MR	R/S	P,E	12300		A	Not functional
Lafourche Ph w/l 540	LA. Delta Farms		84-11-02	4	F/I/B	45,657		WF	R/NS	p,NE	45657		A	
Lafourche Ph w/l 529	LL&E	85	85-07-31	4	B	6,666	22020	WF,MR	R/NS	p,E	6666	22020	P	No structures installed
Lafourche Ph w/l 577	Harrison & Ryan		85-07-31	4	B/S	8,700		WF,MR	R/NS	p,E	8700		A	Not functional
Lafourche Ph w/l 527	Sea Farms (Cheramie)		85-07-31	4	S			MA		Withdrawn	0			
Byou Des Allemands 110	LL&E		85-11-04	4	F	5,976		MR		p,E	5976		P	
Byou Des Allemands 107	Whitney Bank		85-09-04	4	F	678		RE	R/S	C	678		A	Same as Laf P wl 773
		86		4		0	0				0	0		
		87		4		0	0				0	0		
		88		4		0	0				0	0		
Jeff. Ph w/l 192	Little Lake Hunting	89	89-06-21	4	B	450	450	WF,MR	R/S	P,NE	450	450	A	Only the Jeff Ph w/l 229 portion reported
Jefferson Ph w/l 215	Jean Lafitte Park	90	90-06-29	4	I	12,400	12400	WF,MR	R	NW,E	0	0	A	
Lafourche Ph w/l 733	Gheens Foundation	91	91-07-12	4	F	5,385	128525	WF	R/NS	C	5385	128525	A	Partly same as Bayou des Allemands 107
Jeff. Ph w/l 229	US FWS		91-07-31	4	B	140		RE	R/S	C	140		A	Part of Jeff Ph w/l 192
Lafourche Ph w/l 743	Lafourche Parish		91-12-04	4	F/I/B	123,000		MR	R	NW,NE	123000		P	
		92		4		0	0				0	0		
		93		4		0	0				0	0		
Lafourche Ph w/l 718	Plaisance	94	94-05-18	4	S	6,250	6250	MR	R/NS	P,NE	6250	6250	P	
Jefferson Ph w/l 260	Jeff Ph Council	95	95-04-20	4	I/B	7,199	7199	MR	R	NW,NE	7199	7199	P	see CWPPRA (PBA-35)
				SUMS		242,514	242,514				225351	225351		
						N=16	N=16				N=13	N=13		

15,157 Avg Acs/permitted plan in study area (N=16)

17,335 Avg Acs/"implemented" plan in study area (N=13)

Table C-4:Terrebonne Basin (Basin 5)

PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTO ACRES	PURPOSE	MONITORING	STATUS	ADJUSTED ACS ADDED	SUM ADJ. ACS/YR		Comment
		77		5		0	0				0	0		
		78		5		0	0				0	0		
		79		5		0	0				0	0		
		80		5		0	0				0	0		
		81		5		0	0				0	0		
Terrebonne Ph w/l 478	Leonard Chabert	82	82-09-07	5	I	456	781	MR,WF	NR	C	456	456	A	
Terrebonne Ph w/l 496	Terrebonne Land		82-08-30	5	I/B	325		WF,MA	NR	nw,E	0			
Terrebonne Ph w/l 628	Continental L & F	83	83-12-21	5	F	3,350	5498	MR,WF	R/NS	p,E	3350	5498	A	No structures installed
Terrebonne Ph w/l 587	Walter Land Co.		83-12-05	5	F	2,148		MR,WF	R/NS	C	2148		A	For mitiagtion; part of larger unpermitted project
Terrebonne Ph w/l 625	Continental L & F	84	84-02-08	5	F	5,282	12504	MR	NR	p,NE	5282	12504	A	No structures insr
Terrebonne Ph w/l 698	Tenneco, Inc		84-10-10	5	I/B	7,222		MR,WF	R/S	C	7222		A	
St Mary Ph w/l 146	Avoca, Inc	85	85-08-07	5	F	800	800	WF,MR	R/NS	C	800	800	A	Not functional
		86		5		0	0				0	0		
St Louis Canal 7	Terrebonne Aquacult	87	87-08-27	5	F	45	2461	WF,MA	NR	NW,E	0	0		
Lafourche Ph w/l 637	Harold Folse		87-10-02	5	F	2,416		WF	R	nw,E	0			
Terrebonne Ph w/l 822	Harry Bourg Corp	88	88-06-22	5	B	1,152	1152	MR,WF	R	nw,E	0	0		
Falgout Canal 2	Terr. Ph. Govt	89	89-03-03	5	I/B	8,000	10555	MR	R/NS	C	8000	10555	A	
Terrebonne Ph w/l 870	Wylie Heirs		89-09-30	5	F	2,555		MR,WF	R/S	p,E	2555		A	
Lafourche Ph w/l 703	Intracoastal Oilfield	90	90-03-30	5	CT/F	644	2544	WF	R/S	C	644	644	A	
Terrebonne Ph w/l 930	Leonard Chabert		90-08-03	5	F/I	1,900		WF,MR	R	nw,E	0			Basis for Terr P W/L 943
Byou LaLoutre 83	US FWS	91	91-08-24	5	B	340	7440	RE	R/NS	C	340	3340	A	FWS Research
Terrebonne Ph w/l 943	Leonard Chabert		91-09-23	5	F/I	4,100		WF,MR	R	NW,E	0		A	2,200 new acres & 1,900 acres from Terrebonne Parish w/l 930
Terrebonne Ph w/l 953	So. Terr. Tidewater		91-11-20	5	B	3,000		MR	R/NS	C	3000		P	
		92		5		0	0				0	0		
		93		5		0	0				0	0		
Terrebonne Ph w/l 991	So. Terr Tidewater	94	94-05-12	5	B	4,374	5274	MR	R/NS	P,NE	4374	5274	A	Supercedes prior mgt plan
Grand Bayou 169	LaPlante & Naquin		94 07-21	5	F	900		WF	R/NS	P,NE	900		A	
Lafourche Ph w/l 675a	Naquin	95	95-03-17	5	F/I	950	1754	WF,MR	R/NS	p,NE	950	1754	A	
Terrebonne Ph w/l 1043	NMFS		Withdrawn	5	B/S	4,200	0	MR			0			
Terrebone Ph w/l 1044	NMFS		95-10-07	5	B/S	804		MR	R/NS	P,NE	804		P	CWPPRA project PTE-23/33
				SUMS		54,963	50,763				40,825	40,825		
						N=22	N=21				N=15	N=15		

2,417 Avg Acs/permitted plan in study area (N=21)

2,722 Avg Acs/'implemented' plan in study area (N=15)

Table C-5: Atchafalya Basin (Basin 6)

PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORIN	STATUS	ADJUSTE ACS ADD	SUM ADJ. ACS/YR	Comment
		77		6		0	0				0	0	
		78		6		0	0				0	0	
		79		6		0	0				0	0	
		80		6		0	0				0	0	
		81		6		0	0				0	0	
		82		6		0	0				0	0	
		83		6		0	0				0	0	
		84		6		0	0				0	0	
		85		6		0	0				0	0	
		86		6		0	0				0	0	
		87		6		0	0				0	0	
		88		6		0	0				0	0	
		89		6		0	0				0	0	
		90		6		0	0				0	0	
		91		6		0	0				0	0	
		92		6		0	0				0	0	
		93		6		0	0				0	0	
		94		6		0	0				0	0	
		95		6		0	0						
				SUMS		0	0				0	0	

0 Avg Acs/permitted plan

Avg Acs/"implemented" plan

Table C-6: Teche-Vermilion Basin (Basin 7)

PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORING	STATUS	ADJUSTED ACS ADDED	SUM ADJ. ACS/YR		Comment
		77		7		0	0				0	0		
		78		7		0	0				0	0		
		79		7		0	0				0	0		
		80		7		0	0				0	0		
Vermilion Ph w/I 136	Isidore Delcambre	81	81-10-30	7	B	1,200	1200	MR,FB	NR	C	1200	1200	A	Reacquire mgt. capability
		82		7		0	0				0	0		
Vermilion Ph w/I 151	Vermilion School Brd	83	83-01-07	7	F/I	640	6023	WF	NR	C	640	5890	A	Reacquire/improve mgt. capability; not functional
LTAV 181-A	Prior Exploration		83-02-25	7	I/B	750		MR,WF	NR	p,E	750		P	Mitigation (incomplete); reacquire/imporve mgt. capability
Iberia Ph w/I 84	McIlhenny Co.		83-05-04	7	F/I	4,500		MR,WF/FB	NR	C	4500		P	Acquire mgt. capability
St Mary Ph w/I 115	Stone Petroleum		83-08-21	7	F	133		WF	NR	NW,E	0		A	Acquire mgt. capability
		84		7		0	0				0	0		
		85		7		0	0				0	0		
Freshwater Bayou 27	Vermilion Corp	86	86-03-06	7	I	3,900	9440	WF,MR	R/S	C	3900	9440	A	Acquire mgt. capability
Vermilion Ph w/I 221	Donald Caldwell		86-08-29	7	B	690		MR,WF	NR	p,E	690		A	Acquire mgt. capability
St Mary Ph w/I 153	Miami Corp		86-10-20	7	F	3,085		MR,WF	NR	P,NE	3085		P	Reacquire/expand mgt. capability; not functional
Vermilion Ph w/I 239	Mike Pettit		86-12-01	7	B	1,765		MR,WF	R/NS	C	1765		A	Upgrade/expand mgt. capability
Vermilion Ph w/I 236	Vermilion Bay Land	87	87-03-31	7	B	1,035	1035	MR,WF	R/S	C	1035	1035	A	Acquire greater mgt capability, expansion of LTAV 181a
		88		7		0	0				0	0		
Bayou Cassmer 1	Cashco Oil	89	89-04-19	7	B	1,100	1100	MR,FB/WF	R	nw,E	0	0	P	Mitigation; acquire mgt. capability
		90		7		0	0				0	0		
		91		7		0	0				0	0		
Vermilion Ph w/I 272	Leslie Godchaux	92	92-08-04	7	I/B	6,570	6928	MR,WF	R/S	C	6570	6928	A	Reacquire/expand mgt. capability
Vermilion Ph w/I 297	Guy Broussard		92-08-07	7	I	358		MR,WF	R/NS	C	358		A	Retain/prolong existing management capability
Dugas Canal 8	Isadore Delcambre	93	93-02-09	7	I	500	750	MR,WF	R	NW,E	0	0	A	Reacquire hydrologic integrity of currently managed area
Bayou Portage	Isadore Delcambre		93-03-27		I	250		MR,WF	R	NW,E	0		A	Reacquire hydrologic integrity of currently managed area
		94		7		0	0				0	0		
St. Mary Ph w/I 195a	St. Mary SWCD	95	95-09-15	7	F	30000	30000	MR	R	NW,NE	30000	30000	A	See CWPPRA, TV-4
				SUMS		56,476	56,476				54,493	54,493		
						N=16	N=16				N=12	N=12		

3,530 Avg Acs/permitted plan in study area (N=16)

4,541 Avg Acs/'implemented' plan in study are (N=12)

Table C-7: Mermentau Basin (Basin 8)

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PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORING	STATUS	ADJUSTED ACS ADDE	SUM ADJ. ACS/YR	WATER MGT	Comment
Little Pecan Bayou 5	Little Pecan Prop.	77	77-05-12	8	I/B	5,000	5000	WF/FB	R/S	C	5000	5000	A	Upgrade/expand mgt. capability; see Cameron Ph w/l 1014
		78		8		0	0				0	0		
		79		8		0	0				0	0		
		80		8		0	0				0	0		
		81		8		0	0				0	0		
LTVM 94 1/2	Lake Arthur Recl	82	82-08-19	8	F	2,800	6500	WF	NR	C	0	0	P	Outside study area
Schooner Bayou 7	Verm Ph Pol Jur		82-08-24	8	I/B	3,700		MR,WF	NR	C	3700	3700	A	4 of 6 installed for saltwater intrusion
North Bayou 1	Superior Oil	83	83-01-17	8	B	4,100	8100	MR	NR	c,E	4100	8100	P	
Mermentau River 151	Cameron Pol. Jur.		83-07-15	8	B	4,000		MR	R/NS	C	4000		A	Maintain mgt. capability
Creole Canal 2	Cam. Ph GDD 4	84	84-05-25	8	I	3,264	10462	MR	R/S	C	3264	10462	P	Acquire mgt. capability
Vermilion Ph w/l 200	Vermilion Corp		84-09-26	8	B	3,378		MR,WF	R/NS	p,E	3378		A	Acquire additional mgt. capability, semi-impoundment
Vermilion Ph w/l 197	Vermilion Corp		84-10-12	8	F/I	3,820		WF,MR	NR	C	3820		A	
Vermilion Ph w/l 220	Vermilion Corp	85	85-10-25	8	I	2,260	2939	MR,WF	R/S	P,E	2260	2939	A	Acquire mgt. capability, semi-impoundment
Cameron Ph w/l 710	Benny Welch		85-10-28	8	F	279		WF	NR	C	279		P	Reacquire mgt. capability; adjoins area affected by Mermentau River 151
Cameron Ph w/l 770	Brian Domingue	86	86-05-19	8	F/I	400		WF	NR	C	400		A	Reacquire mgt. capability of previously leveed area
		87		8		0	0				0	0		
Cameron Ph w/l 839	Cam. Ph GDD 5	88	88-05-11	8	F/I	960	960	MR,WF	R/NS	C	960	960	A	Reacquire integrity against saltwater intrusion
Vermilion Ph w/l 252	Vermilion Corp	89	89-09-12	8	F/I/B	10,398	10398	MR,WF	R/S	P,E	6298	6298	A	Upgrade/expand mgt. capability; extension from 4100 acres from North Bayou 1
Cameron Ph w/l 887	Henry Mayer	90	90-03-24	8	B	1,419	8574	WF	R/S	C	1419	8574	A	
Vermilion Ph w/l 280	Semmes Lynch		90-04-26	8	B	405		WF,MR	R/S	C	405		A	Reacquire/upgrade mgt. capability
Cameron Ph w/l 906	Miami Corp		90-10-29	8	F/I	6,750		MR	R/S	C	6750		A	Acquire mgt. capability
Vermilion Ph w/l 285	Vermilion Corp	91	91-08-17	8	F	500	1300	MR	R/NS	P,E	0	0		Large-scale fresh water diversion
Cameron Ph w/l 912	John John		91-09-26	8	F/I	800		WF/FB	R	nw,E	0			Reacquire/upgrade mgt. capability
		92		8		0	0				0	0		
		93		8		0	0				0	0		
CameronPh w/l 1021	Coastal Club	94	94-12-21	8	F	850	850	WF/FB	R/NS	p,NE	0	0	A	Outside study area; reacquire/upgrade mgt. capability
Cameron Ph w/l 1014	Miami Corp.	95	95	8	F/I/B	2,700	2700	MR	R/NS	NW,NE	2700	2700	A	CWPPRA's PME-14
Vermilion Ph w/l 321	Verm Corp.		Pending	8	I	36,000		MR		N/A	0			Contained within boundaries of Little Pecan Bayou 5
				SUMS		93,781	57,781				48,731	48,731		
3,007	Avg Acs/permitted plan in study area (N=18)	3,046	Avg Acs/'implemented' plan in study area (N=16)			N=21	N=20				N = 18	N=16		

Table C-8: Calcasieu-Sabine Basin (Basin 9)

PERMIT NUMBER	APPLICANT	CALENDAR YEAR	PERMIT DATE	HYDRO UNIT	MARSH TYPE	APPLIED ACRES	PRMTTD ACRES	PURPOSE	MONITORING	STATUS	ADJUSTED ACS ADDED	SUM ADJ. ACS/YR	WATER MGT	Comment
		77		9		0	0				0	0		
		78		9		0	0				0	0		
		79		9		0	0				0	0		
Calcasieu Lake 382	Cam. Ph GDD 3	80	80-10-16	9	I/B/S	66,000	66000	MR	R/S	P,E	66000	66000	A	Some aspects subject to CWPPRA
		81		9		0	0				0	0		
Black Lake 30	Amoco (Derouen)	82	82-08-18	9	F/I	768	768	WF	NR	nw/E	0	0	A	
Oyster Bayou 7	Wm T Burton Indust	83	83-08-10	9	B	1,850	1850	MR,WF	NR	C	1850	1850	A	Reacquire/upgrade mgt. capability against saltwater intrusion
Cameron Ph w/l 611	James & JB Constance	84	84-08-19	9	B	35	35	MA,WF,FB	NR	p,E	35	35	A	
		85		9		0	0				0	0		
Cameron Ph w/l 744	Amoco	86	86-05-15	9	F/I	6,620	6620	WF	R/S	C	6620	6620	A	see XCS-48 (NO-4)
		87		9		0	0				0	0		
		88		9		0	0				0	0		
		89		9		0	0				0	0		
LTMC 59	Miami Corp	90	90-05-04	9	F	400	400	MR/WF	R/S	C	0	0	A	Contained within (Calcasieu Lake)382, abuts basin boundary
Cameron Ph w/l 863	T. Shaughnessy	91	91-01-16	9	B	800	8922	WF	R/S	C	800	2173	A	
#19231	Lawton & Gum Cove		91-05-20	9	I/B	8749		MR/WF		p,ne	0			Abuts but north of basin boundary; Galveston Dist COE
Cameron Ph w/l 832	Amoco (Murphy)		91-10-11	9	F/I	1,373		WF/MR	R/NS	C	1373		A	
Cameron Ph w/l 923	Fina	92	92-03-26	9	B/S	7,224	18920	MR/WF	R/NS	p,NE	7224	13634	A	
Cameron Ph w/l 831	Amoco (Duhon)		92-07-23	9	B	786		MR/WF	R/NS	nw,E	0			
Cameron Ph w/l 963	Cameron GDD 9		92-07-31	9	F/I	6,575		MR/WF	R/NS	c	6575		A	
Calcasieu Ph w/l 67	B. Watts		92-08-18	9	I/B	35		WF	R/S	C	35		A	
Cameron Ph w/l 967	Fina Oil		92-11-30	9	B	3600		MR,WF	R/NS	NW,E	0		A	Former mitigation project; see XCS-48 (SO-5)
Calcasieu Ph w/l 59	Belle Krause		92-09-15	9	F/I	700		MR			0	0		Ouside basin boundary
		93		9		0	0				0	0		
Cameron Ph w/l 967	Amoco	94	Withdrawn	9		2,794	0							
#20051	Cam. Ph GDD 7	95	95-04-06	9	I/B	1,200	2200	MR	?	NW	1200	1200		Estimated acreage
Cameron Ph w/l 1036	North Am. Land		95-10-27	9	B	1,000		MR/WF	R/NS	nw,NE	0	0	A	Project area within footprint of Calcasieu Lake 382
				SUMS		106,509	105,715				91,712	91,712		
	6,551 Avg Acs/permitted plan in study area (N=15)		9,171 Avg Acs/'implemented' plan in study area (N=10)											
						N=18	N=17				N=10	N=10		

Table C-9: Permits (C/PI/I Projects) - Basin by Year (Summary)

	1	2	4	5	6	7	8	9	Delta	Cumm Delta	Chenier	Cumm Chenier	Year Totals	Cumm Totals	Year Avgs (correct)	Year N	Cumm N	Cumm Av
77							5000				5000	5000	5000	5000	5000	1	1	5000
78												5000	0	5000	0	0	1	5000
79												5000	0	5000	0	0	1	5000
80								66000			66000	71000	66000	71000	66000	1	2	35500
81						1200			1200	1200		71000	1200	72200	1200	1	3	24067
82		2260		456			3700		2716	3916	3700	74700	6416	78616	2139	3	6	13103
83			2950	5498		5890	8100	1850	14338	18254	9950	84650	24288	102904	2699	9	15	6860
84	4200		57957	12504			10462	35	74661	92915	10497	95147	85158	188062	9462	9	24	7836
85			22020	800			2939		22820	115735	2939	98086	25759	213821	3680	7	31	6897
86						9440		6620	9440	125175	6620	104706	16060	229881	2677	6	37	6213
87	834					1035		1	1869	127044		104706	1869	231750	935	2	39	5942
88	12640						960		12640	139684	960	105666	13600	245350	6800	2	41	5984
89			450	10555			6296		11005	150689	6296	111962	17301	262651	4325	4	45	5837
90				644			8574		644	151333	8574	120536	9218	271869	2305	4	49	5548
91			128525	3340				2173	131865	283198	2173	122709	134038	405907	19148	7	56	7248
92						6928		13834	6928	290126	13834	136543	20762	426669	4152	5	61	6995
93	13974								13974	304100		136543	13974	440643	13974	1	62	7107
94			6250	5274					11524	315624		136543	11524	452167	3841	3	65	6956
95			7199	1754		30000	2700	1200	38953	354577	3900	140443	42853	495020	8571	6 7	71	6972
Totals	31648	2260	225351	40825	0	54493	48731	91712	354577		140443		495020			71		
N=	4	1	13	15	0	12	16	10	45		26		71					

Table C-10: Permits (C/PI/I Projects) - Basin by Included Marsh Type

Included Marsh Types	Basins 1	2	4	5	6	7	8	9	Delta Totals	Chenier Totals	Coast Totals
F			5976 678 5385	3350 5282 800 644 2555 900 2148		3085 30000	279		60803	279	61082
F/I				950		640 4500	3620 400 960 6750	6620 1373 6575	6090	26498	32588
I				456		3900 358	3264 2260		4714	5524	10238
F/I/B			45657 123000				6296 2700		168657	8996	177653
I/B	12640		7199	7222 8000		6570 750	5000 3700	35 1200	42381	9935	52316
B	4200 13974	2260	6666 450 140	340 3000 4374		1200 690 1765 1035	4100 4000 405 3378 1419	1850 55 800	40094	15987	56081
I/B/S								66000		66000	66000
B/S			2950 8700	804				7224	12454	7224	19678
S	834		12300 6250						19384		19384
TOTALS	31648	2260	225351	40825	0	54493	48731	91712	354577	140443	495020
N	4	1	13	15	0	12	16	10	45	26	71

Table C-11: Permits (C/P/I Projects) Summary - Implemented acres by basin and marsh type

Marsh Type	1	2	4	5	6	7	8	9	Delta Tot	Chenier Tot	Coast Tot	Delta Avg	Chenier Avg	Coast Avg
F			12039	15679		33085	279		60803	279	61082	5067	279	4699
F/I				950		5140	11930	14568	6090	26498	32588	2030	3785	3259
I				456		4258	5524		4714	5524	10238	1571	2762	2048
F/I/B			168657				8996		168657	8996	177653	84329	4498	44413
I/B	12640		7199	15222		7320	8700	1235	42381	9935	52316	7064	2484	5232
B	18174	2260	7256	7714		4690	13302	2685	40094	15987	56081	3084	1776	2671
I/B/S								66000		66000	66000		66000	66000
B/S			11650	804				7224	12454	7224	19678	4151	7224	4920
S	834		18550						19384		19384	6461		6461
Totals	31648	2260	225351	40825		54493	48731	91712	354577	140443	495020			

Table C-12: Permits (C/P/I Projects)- Basin by Purpose

Purpose	Basin 1	2	4	5	6	7	8	9	Purpose Totals
WF n=12			45657 5385	644 900		640	5000 1419 279 400	800 35 6620	67779
MR n=18			5976 2950 123000 6250 7199	5282 8000 3000 4374 804		30000	4100 4000 3264 6750 2700	66000 1200	284849
WF/MR n=36	4200 12640 13974	2260	12300 6666 8700 450	3350 800 950 2555 456 2148 7222		1200 4500 690 1765 1035 3900 3085 6570 750 358	3700 3820 3378 2260 960 6296 405	1850 1373 7224 6575	140365
RE n=3			140 678	340					1158
Other (WF/MA, MR/FB, WF/FB) n=2	834							35	869
Basin Tots	31648	2260	225351	40825	0	54493	48731	91712	495020
Region Tots						354577 Delta n=45		140443 Chenier n=26	495020 Coast n=71

Table C-13: Summary- Permits (C/P/I Projects - Purpose by Basin

Purpose	Basin 1	Basin 2	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9	Coastwide Totals	Delta Totals	Chenier Totals	Delta Avg	Chenier Avg	Coastwide Avg
WF			51042	1544		640	7098	7455	67779	53226	14553	10645	2079	5648
WF/MR	30814	2260	28116	17481		23853	20819	17022	140365	102524	37841	4101	3153	3899
MR			145375	21460		30000	20814	67200	284849	196835	88014	17894	12573	15825
RE			818	340					1158	1158		386		386
Other	834							35	869	834	35	834	35	435
TOTAL	31648	2260	225351	40825		54493	48731	91712	495020	354577	140443	7879	5202	6972
n=	4	1	13	15		12	16	10	71					

TableC-14: Permits (C/P/I Projects) - Summary of Average Size Basin by Purpose

	Basin 1 Avg	Basin 2 Avg	Basin 4 Avg	Basin 5 Avg	Basin 6	Basin 7 Avg	Basin 8 Avg	Basin 9 Avg	Delta	Delta Avg	Chenier	Chenier Avg	Coast Avg	Coast
WF			25521	772		640	1775	2485	53226	10645	14553	2079	5648	67779
WF/MR	10271	2260	7029	2497		2385	2974	4256	102524	4101	37841	3153	3794	140365
MR			29075	4292		30000	4163	33600	196835	10935	88014	12573	15825	284849
RE			409	340					1158	386			386	1158
Other	834							35	834	834	35	35	435	869
Totals									354577		140443			495020
										495020				

Table C-15: Permits (C/P/I Projects)- Included Marsh Type(s) by Purpose

Included Marsh Type(s)	Purpose					
	WF	WF/MR	MR	Res	Other	TOTALS
F	644	3350	5976	678		61082
	5385	800	5282			
	279	3085	30000			
	900	2555				
		2148				
F/I	640	3820	6750			32588
	400	960				
	6620	4500				
		950				
		1373				
		6575				
I		456	3264			10988
		2260				
		3900				
		750				
		358				
F/I/B	45657	6296	123000			177653
			2700			
I/B	5000	7222	1200			51566
	35	6570	7199			
		3700	8000			
		12640				
B	800	13974	3000	140	35	56081
	1419	4200	4374	340		
		2260	4100			
		6666	4000			
		450				
		1200				
		690				
		1765				
		1035				
		1850				
		3378				
		405				
I/B/S			66000			66000
B/S		8700	2950			19678
		7224	804			
S		12300	6250		834	19384
Totals	67779	140365	284849	1158	869	495020
Average	5648	3899	15825	386	435	6972
n	12	36	18	3	2	71

Table C-16: Permits (C/PI/I Projects) Summary - Marsh Type by Purpose

			Purpose			CT	CT
Marsh Type	WF	WF/MR	MR	Res	Other	Tots	Avgs
F	7208	11938	41258	678		61082	4699
F/I	7660	18178	6750			32588	3259
I		7724	3264			10988	1831
F/I/B	45657	6296	125700	0	0	177653	44413
I/B	5035	30132	16399			51566	5730
B	2219	37873	15474	480	35	56081	2671
I/B/S			66000			66000	16500
B/S		15924	3754			19678	19678
S		12300	6250		834	19384	6461
Totals	67779	140365	284849	1158	869	495020	
Why Avgs	5648	3899	15825	386	435	6972	
n	12	36	18	3	2	71	

Table C-17: Permits (C/PI/I Projects) - Summary Average Initiated Acres - Marsh Type by Purpose

Included Marsh Type	WF	WF/MR	Purpose MR	Res	Other [1]	CT Avg Tots	Tot N
F	1802	2388	1289	678		4699	13
F/I	2553	3030	6750			3259	10
I		1545	3264			1831	6
F/I/B	45657	6296	62850			44413	4
I/B	2518	7533	5466			5730	9
B	1110	2913	5158	240	35	2671	21
B/S		0	33000			16500	4
I/B/S			3754			19678	1
S		12300	6250		834	6461	3

Table C-18: Permits (C/P/I Projects)- Purpose by Year

	WF	WF/MR	MR	Res	Other	Totals
77	5000					5000
78						0
79						0
80			66000			66000
81						1200
		1200				
82		456				6416
		3700				
		2260				
83	640	2148	2950			24288
		4500	4100			
		3350	4000			
		1850				
		750				
84	45657	4200	5282		35	85158
			3284			
		12300				
		7222				
		3378				
		3820				
85	279	2260	5976	678		25359
		6666				
		8700				
		800				
86	400	3085				18460
	6620	690				
		1785				
		3900				
87		1035			834	1869
88		12640				13600
		960				
89		450	8000			17301
		2555				
		6296				
90	644	405	6750			9218
	1419					
91	5385		123000	140		134038
	800	1373	3000	340		
92	35	6570				20762
		7224				
		6575				
		358				
93		13974				13974
94	900		6250			11524
			4374			
95		950	7199			42853
			804			
			30000			
			2700			
			1200			
Totals	67779	140365	284849	1158	869	495020
Avg	5648	3899	15825	386	435	6972
n	12	36	18	3	2	71

Table C-19: Permits (C/PI/I Projects) Summary - Year by Purpose

	WF	WF/MR	MR	RE	Other	Totals	Cumm WF	Cumm WF/MR	Cumm MR	Cumm RE	Cumm Other	Cumm Totals	Avg	N	Cumm N	Cumm Avg	Cumm Tot/ 10000	Avg Acres per Permit
77	5000	0	0	0	0	5000	5000					5000	5000	1	1	5000	0.5	5000
78	0	0	0	0	0	0	5000					5000	0		1	5000	0.5	
79	0	0	0	0	0	0	5000					5000	0		1	5000	0.5	
80	0	0	66000	0	0	66000	5000		66000			71000	66000	1	2	35500	7.1	66000
81	0	1200	0	0	0	1200	5000	1200	66000			72200	1200	1	3	24067	7.2	1200
82	0	6416	0	0	0	6416	5000	7616	66000			78616	1604	3	6	13103	7.9	2139
83	640	12598	11050	0	0	24288	5640	20214	77050			102904	2699	9	15	6860	10.3	2699
84	45657	30920	8546	0	35	85158	51297	51134	85596		35	188062	9462	9	24	7836	18.8	9462
85	279	18426	5976	678	0	25359	51576	69560	91572	678	35	213421	3623	7	31	6885	21.3	3623
86	7020	9440	0	0	0	16460	58596	79000	91572	678	35	229881	2743	6	37	6213	23.0	2743
87	0	1035	0	0	834	1869	58596	80035	91572	678	869	231750	935	2	39	5942	23.2	935
88	0	13600	0	0	0	13600	58596	93635	91572	678	869	245350	6800	2	41	5984	24.5	6800
89	0	9301	8000	0	0	17301	58596	102936	99572	678	869	262651	4325	4	45	5837	26.3	4325
90	2063	405	6750	0	0	9218	60659	103341	106322	678	869	271869	2305	4	49	5548	27.2	2305
91	6185	1373	126000	480	0	134038	66844	104714	232322	1158	869	405907	19148	7	56	7248	40.6	19148
92	35	20727	0	0	0	20762	66879	125441	232322	1158	869	426669	4152	5	61	6995	42.7	4152
93	0	13974	0	0	0	13974	66879	139415	232322	1158	869	440643	13974	1	62	7107	44.1	13974
94	900	0	10624	0	0	11524	67779	139415	242946	1158	869	452167	3841	3	65	6956	45.2	3841
95	0	950	41903	0	0	42853	67779	140365	284849	1158	869	495020	7142	6	71	6972	49.5	7142
Totals	67779	140365	284849	1158	869	495020												6972 Overall Avg

Figure C-15 - Permits: 1977-1995

Avgs: Delta Basins x Purpose

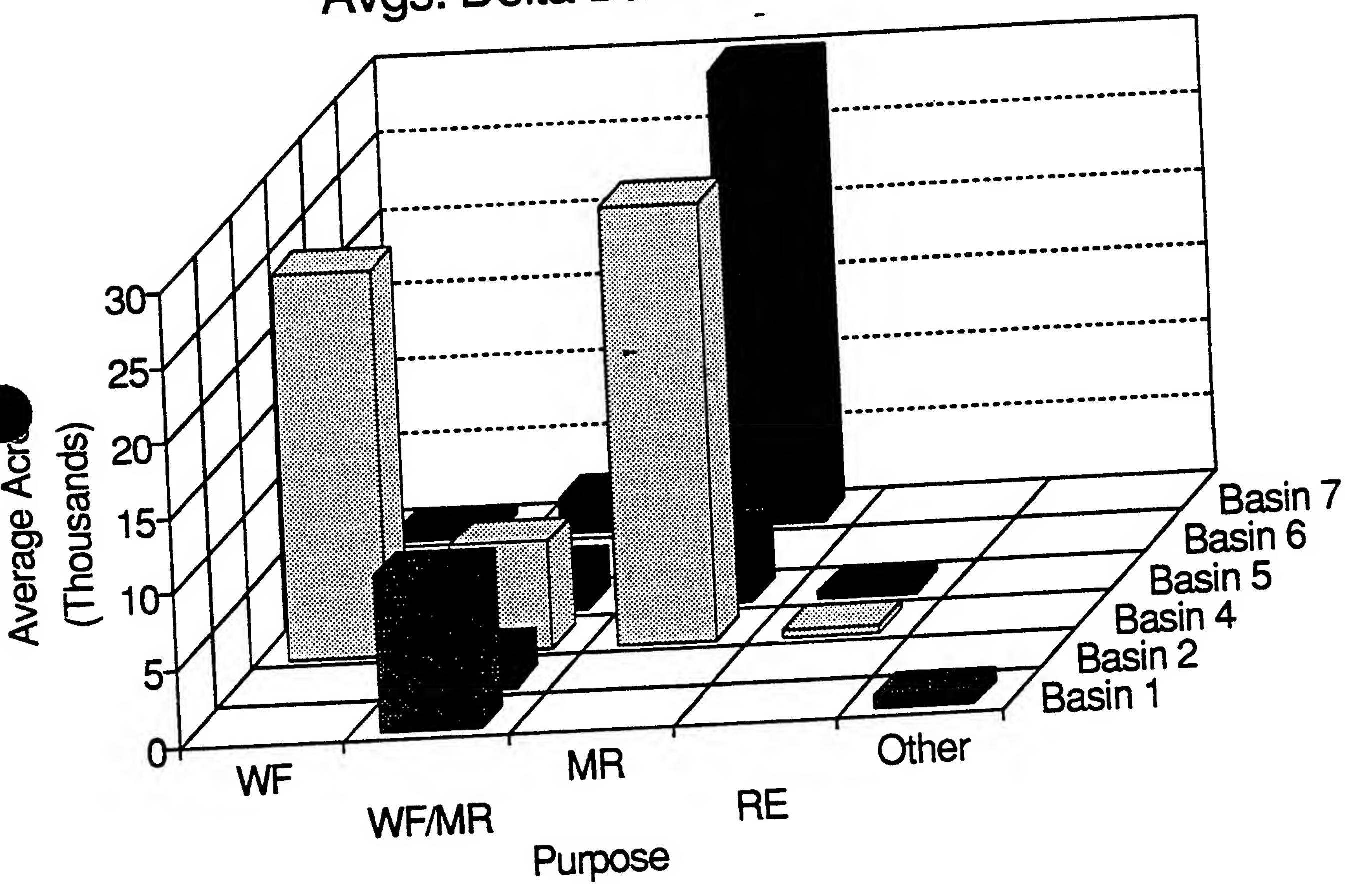


Table C-21: Permits (C/PI/I Projects) - Summary - Marsh Type by Year

	Included Marsh Type														
Year	F	F/I	I	F/I/B	I/B	B	I/B/S	B/S	S	Totals	Cum Averages	Totals	N	Cum N	Cum Avg
77					5000					5000	5000	5000	1	1	5000
78										0	0	5000	0	1	5000
79										0	0	5000	0	1	5000
80							66000			66000	66000	71000	1	2	35500
81						1200				1200	400	72200	1	3	24067
82			456		3700	2260				6416	1283	78616	3	6	13103
83	5498	5140			750	9950		2950		24288	2024	102904	9	15	6860
84	5282	3820	3264	45657	7222	7613			12300	85158	8516	188062	9	24	7836
85	7733		2260			6666		8700		25359	3623	213421	7	31	6885
86	3085	7020	3900			2455				16460	2743	229881	6	37	6213
87						1035			834	1869	935	231750	2	39	5942
88		960			12640					13600	6800	245350	2	41	5984
89	2555			6296	8000	450				17301	3460	262651	4	45	5837
90	644	6750				1824				9218	1844	271869	4	49	5548
91	5385	1373		123000		4280				134038	16755	405907	7	56	7248
92		6575	358		6605	0		7224		20762	5191	426669	5	61	6995
93						13974				13974	13974	440643	1	62	7107
94	900					4374			6250	11524	3841	452167	3	65	6956
95	30000	950		2700	8399			804		42853	14284	495020	6	71	6972
Totals	61082	32588	10238	177653	52316	56081	66000	19678	19384	495020	6972				
Averages	4699	3259	2048	44413	5232	2671	66000	4920	6461	6972					
n	13	10	5	4	10	21	1	4	3	71					

C.2.: Permit Figures

Figure C-1 - Permits: 1977-1995

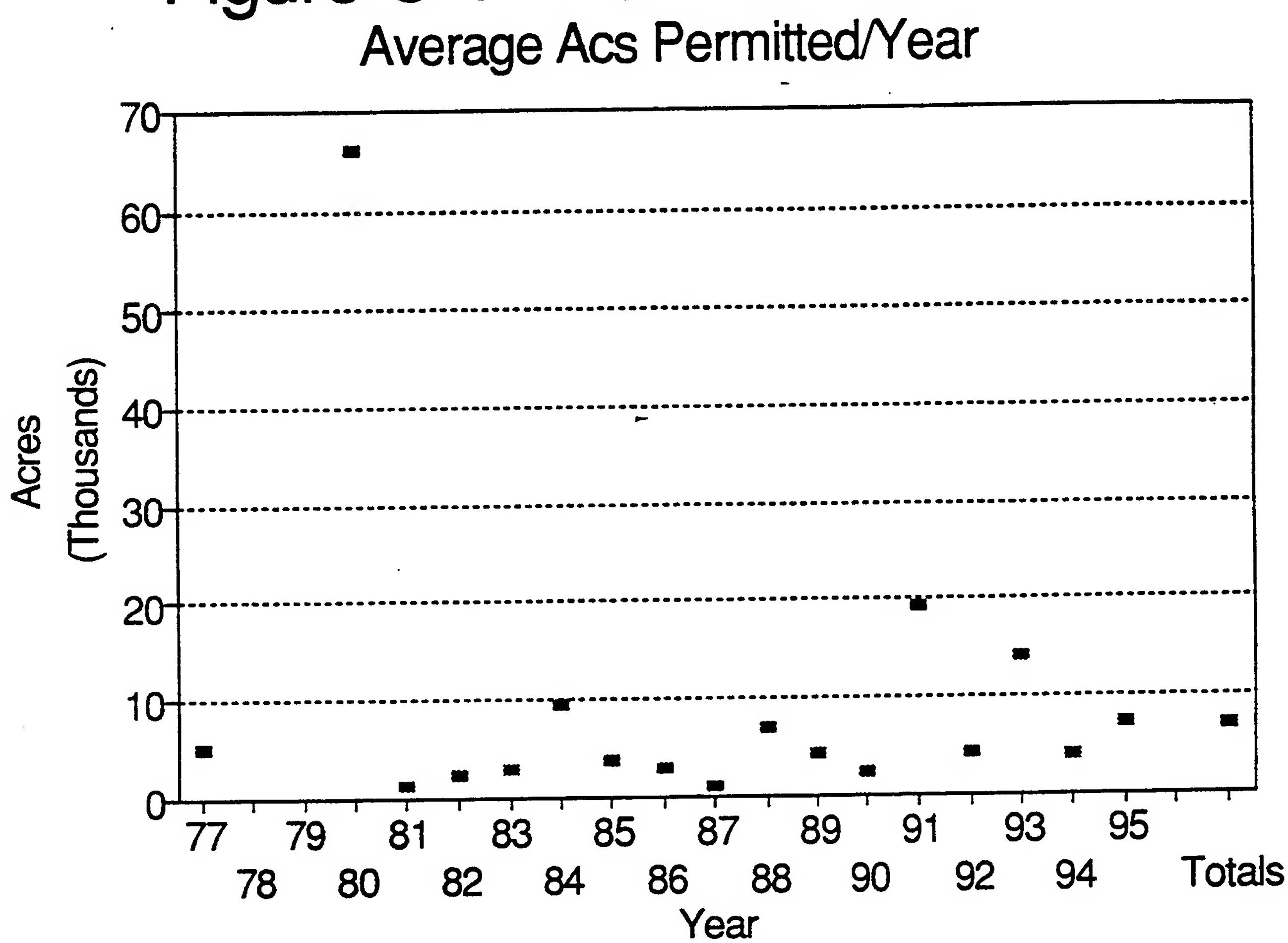


Figure C-2 - Permits: 1977-1995

Cumulative Summary: # & Acres

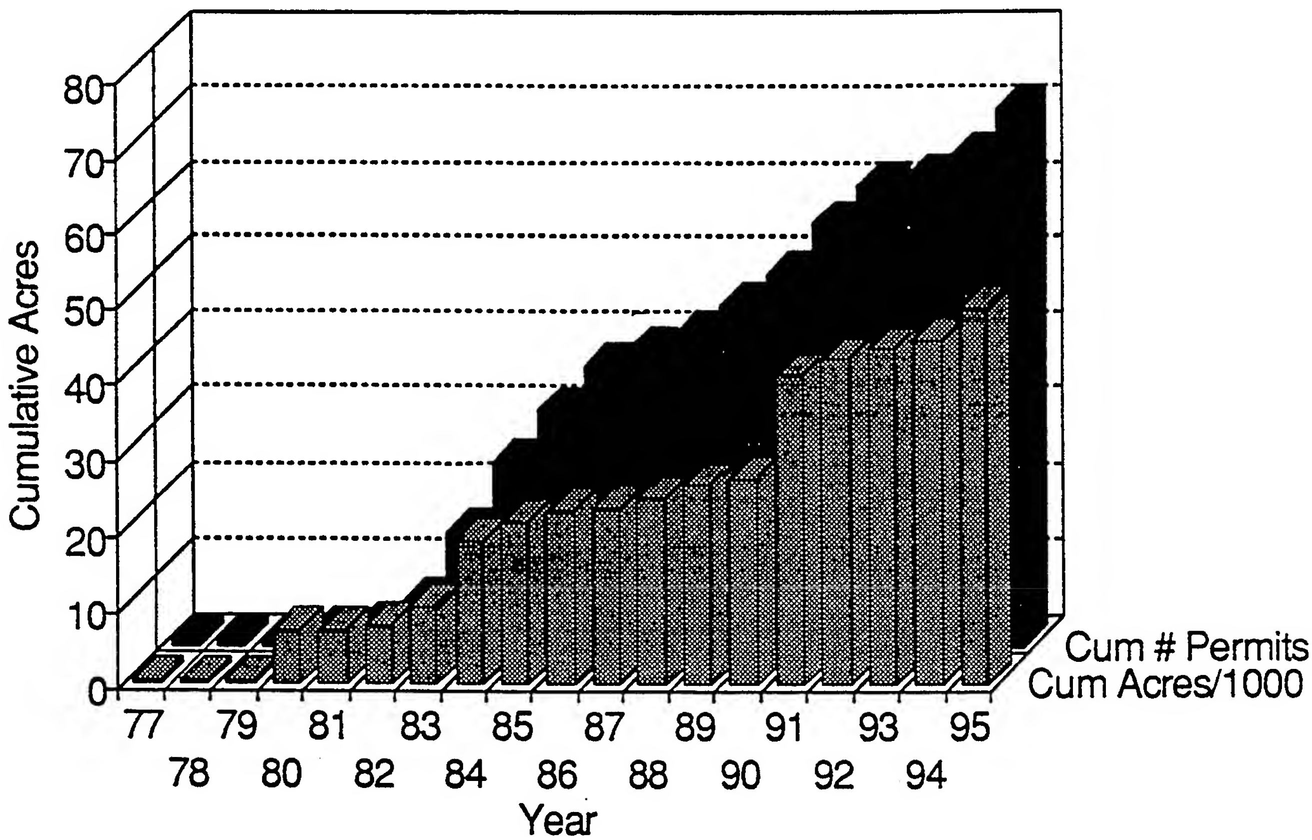


Figure C-3 - Permits: 1977-1995

Year x Region

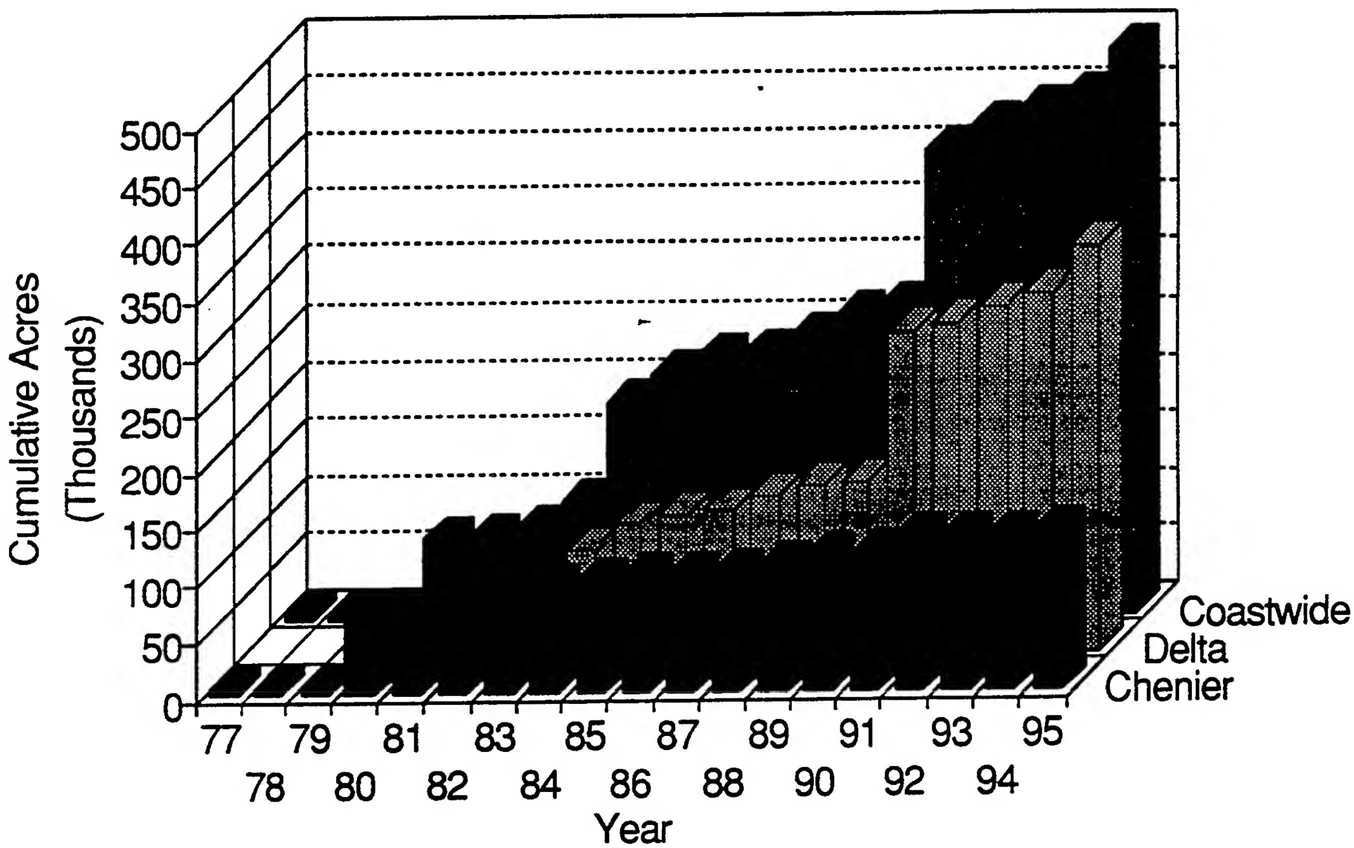


Figure C-4 - Permits: 1977-1995

Year by Purpose

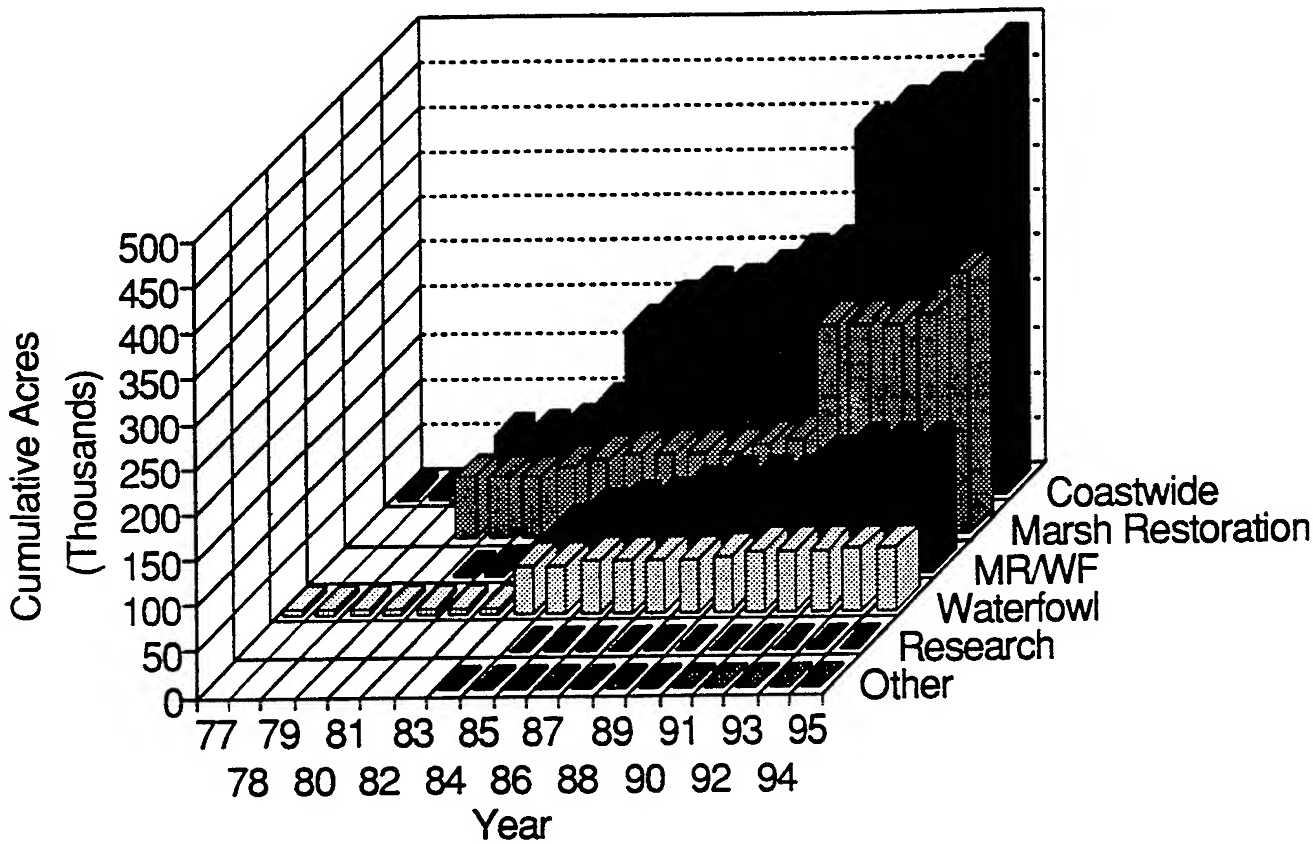


Figure C-5 - Permits: 1977-1995

Region x Purpose

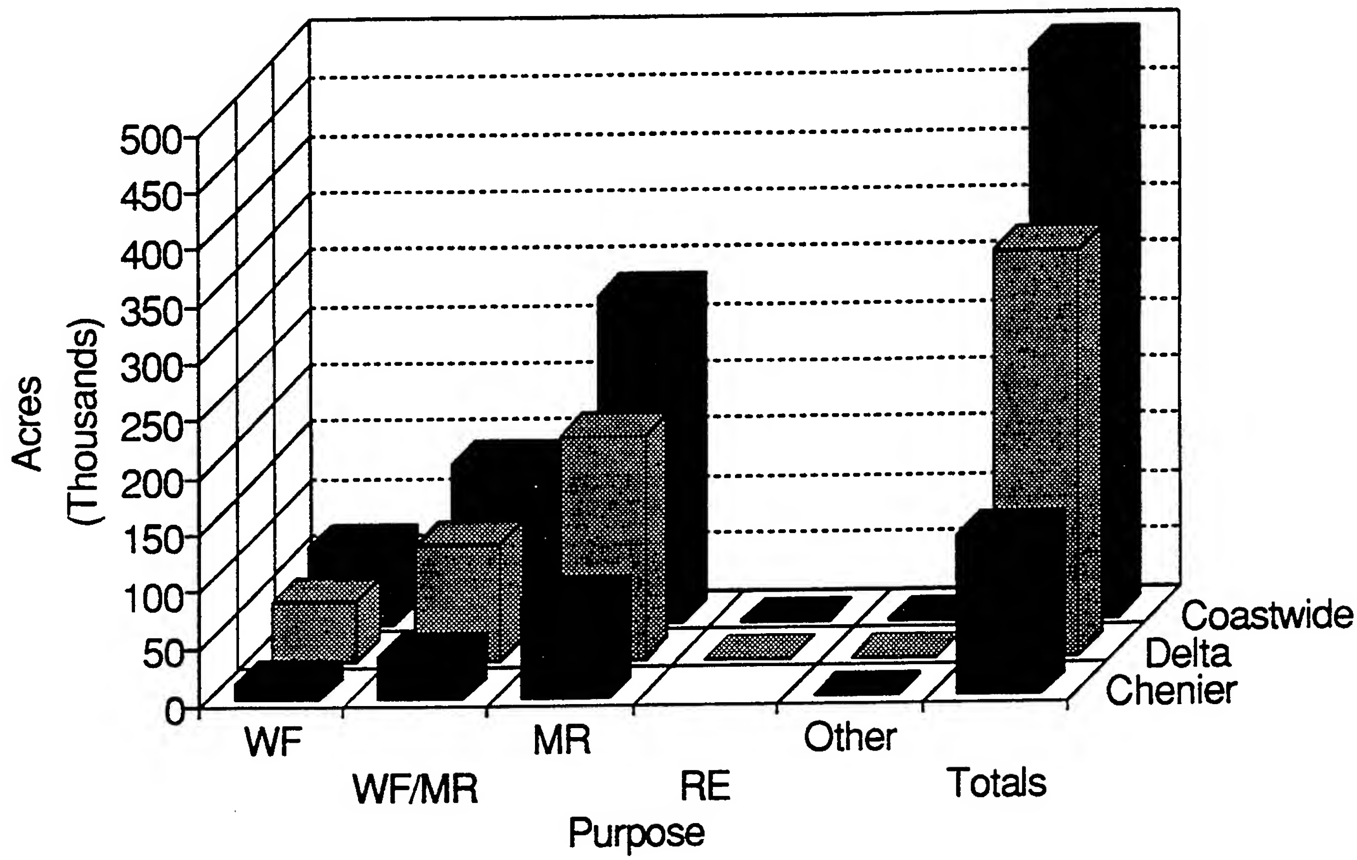


Figure C-6 - Permits: 1977-1995

Delta Basins x Purpose

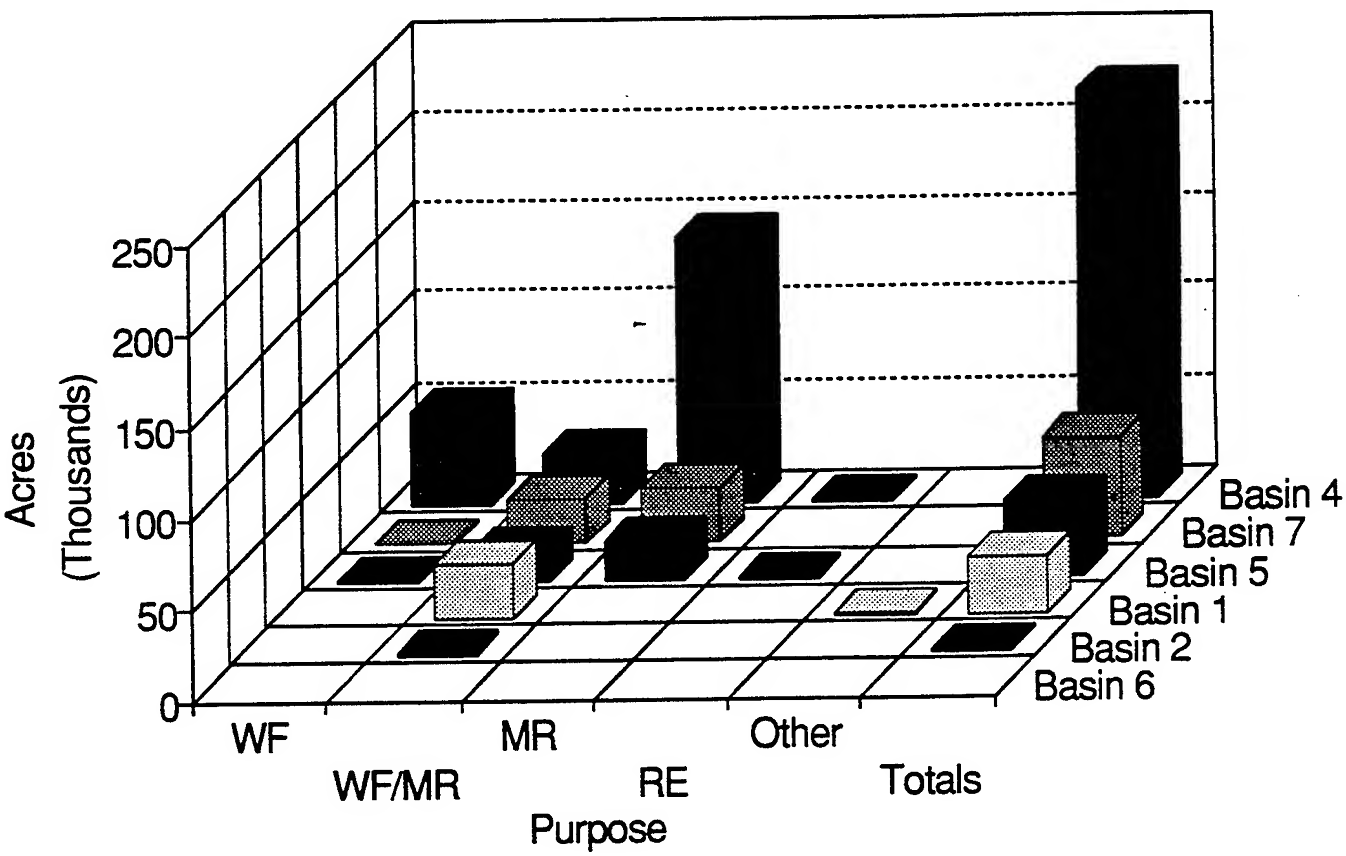


Figure C-7 - Permits: 1977-1995

Chenier Basins x Purpose

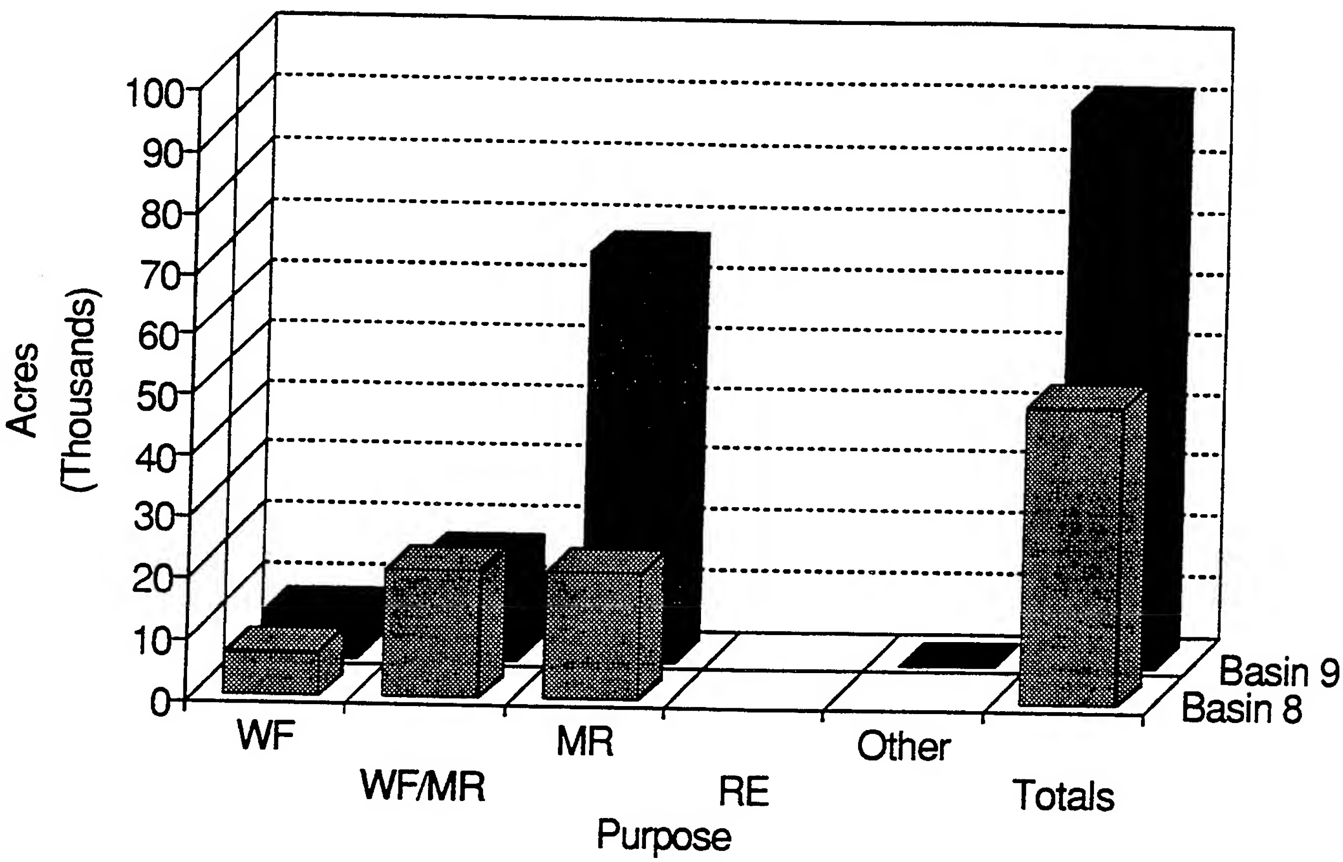


Figure C-8 - Permits: 1977-1995

Marsh Type x Year

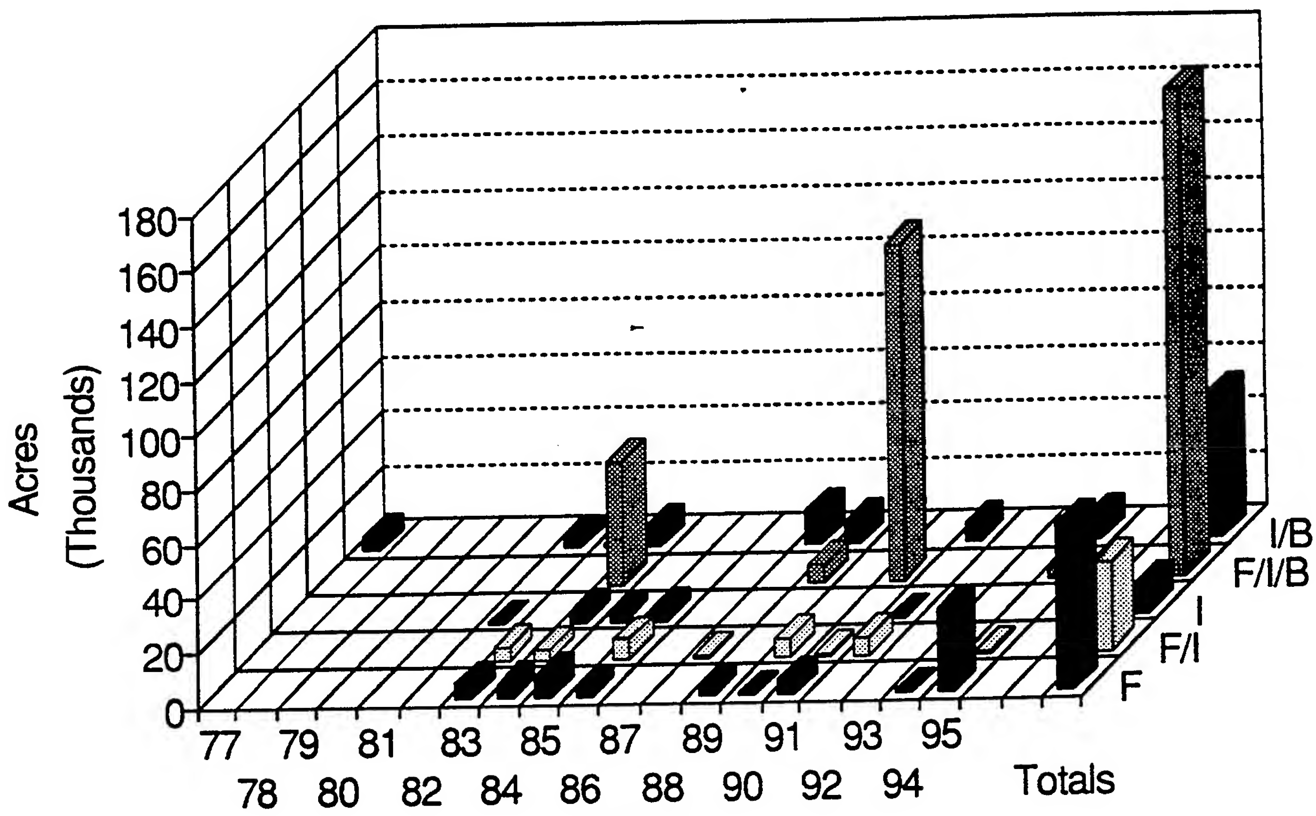


Figure C-9 - Permits: 1977-1995

Marsh Type x Year

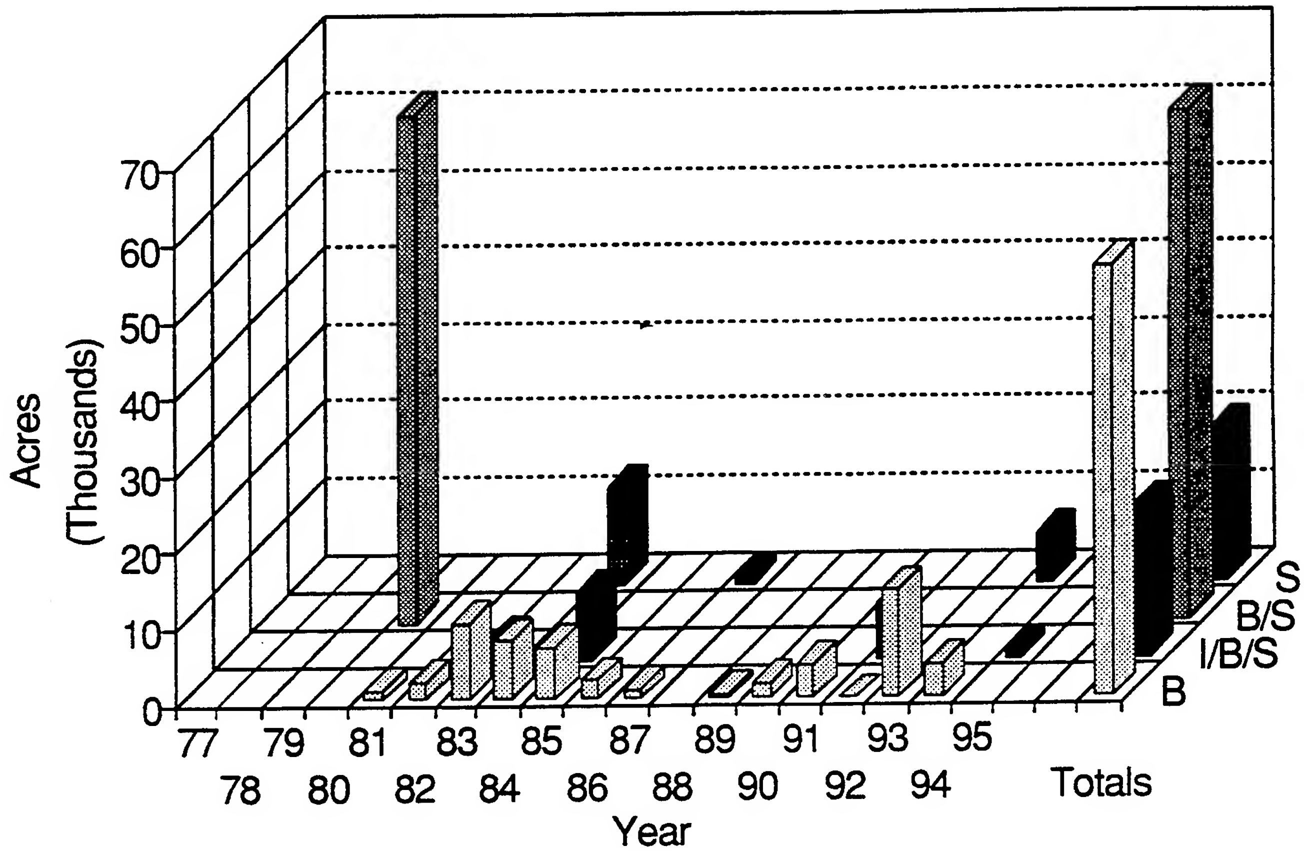


Figure C-10 - Permits: 1977-1995

Purpose x Marsh Type

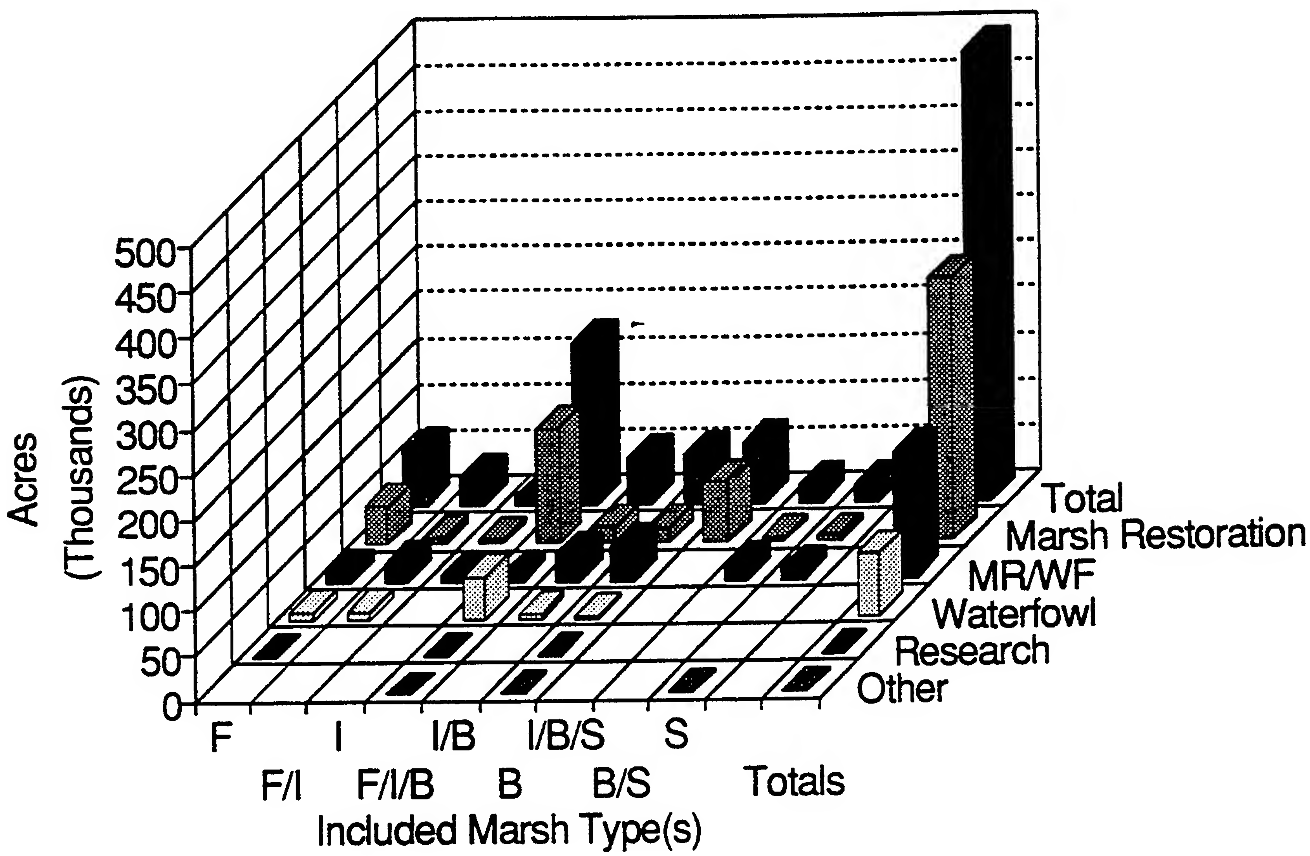


Figure C-11 - Permits: 1977-1995

Region x Marsh Type

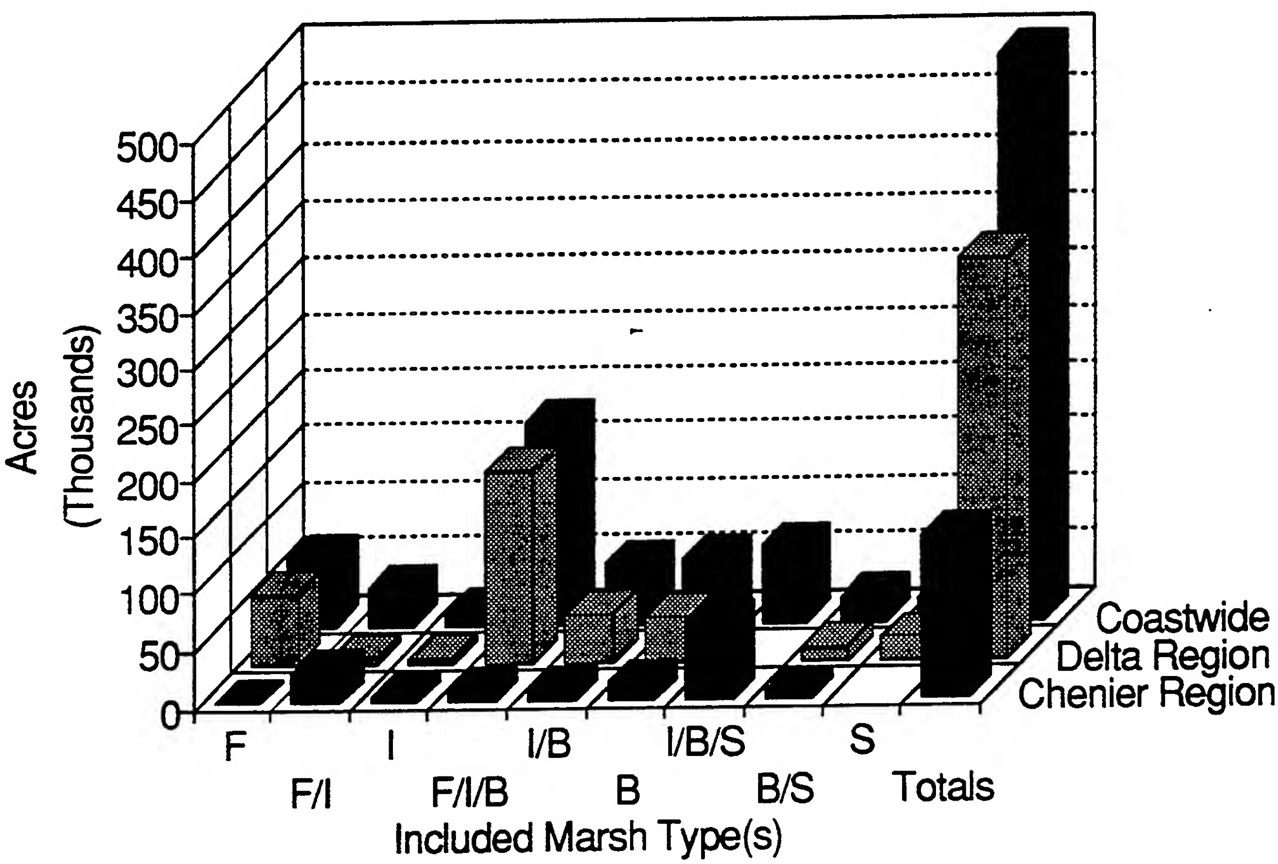


Figure C-12 - Permits: 1977-1995

Delta Basins x Marsh Type

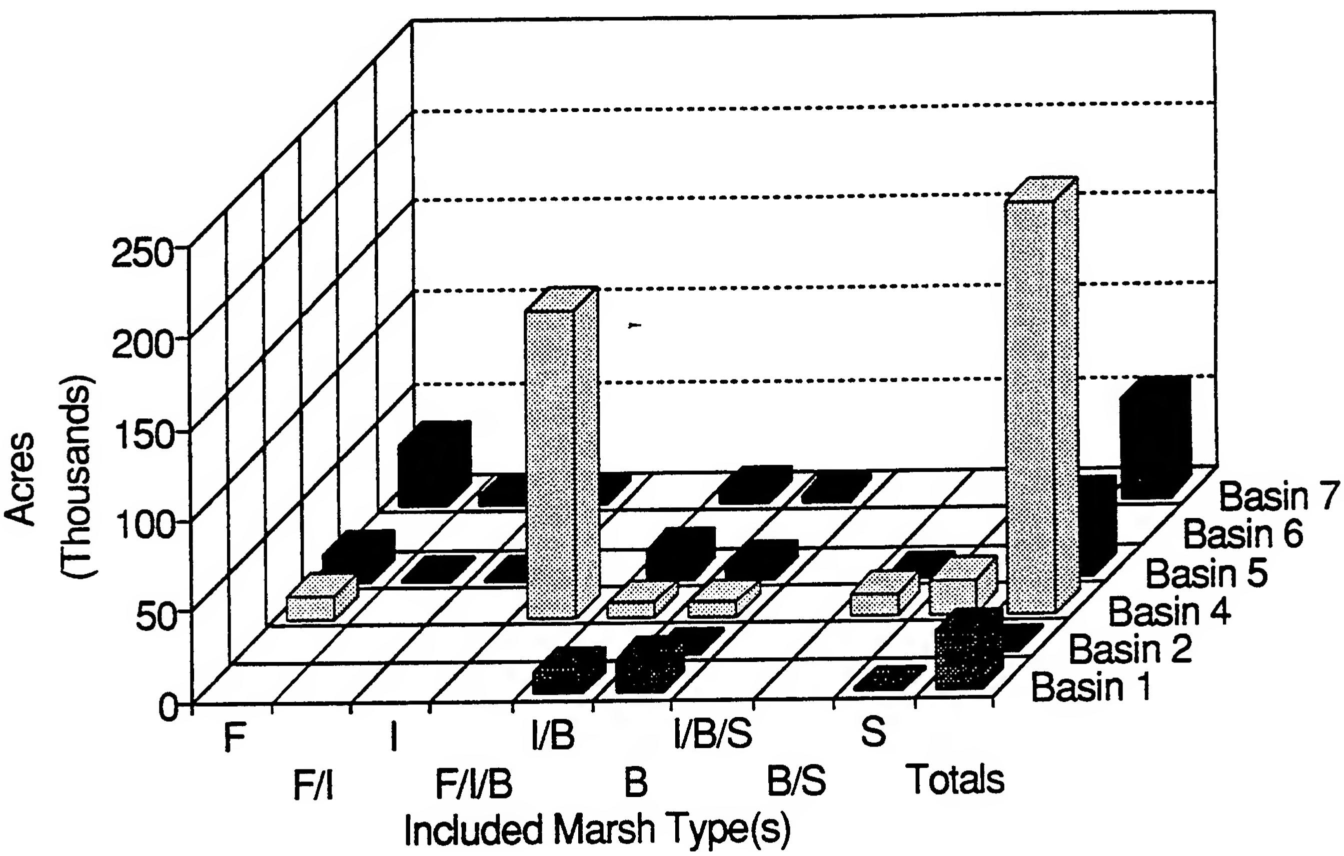


Figure C-13 - Permits: 1977-1995

Chenier Basins x Marsh Type

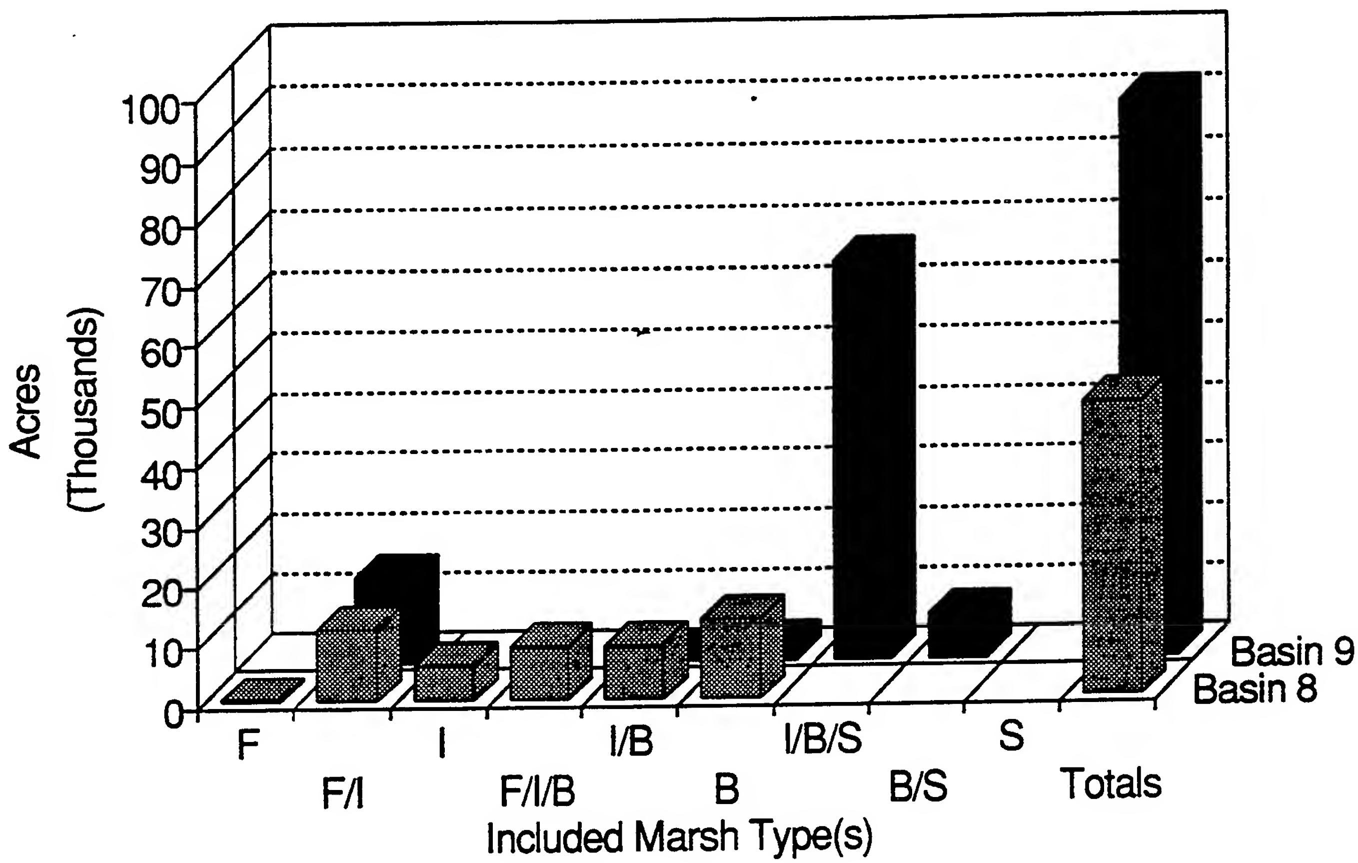


Figure C-14 - Permits: 1977-1995

Avgs: Region x Purpose

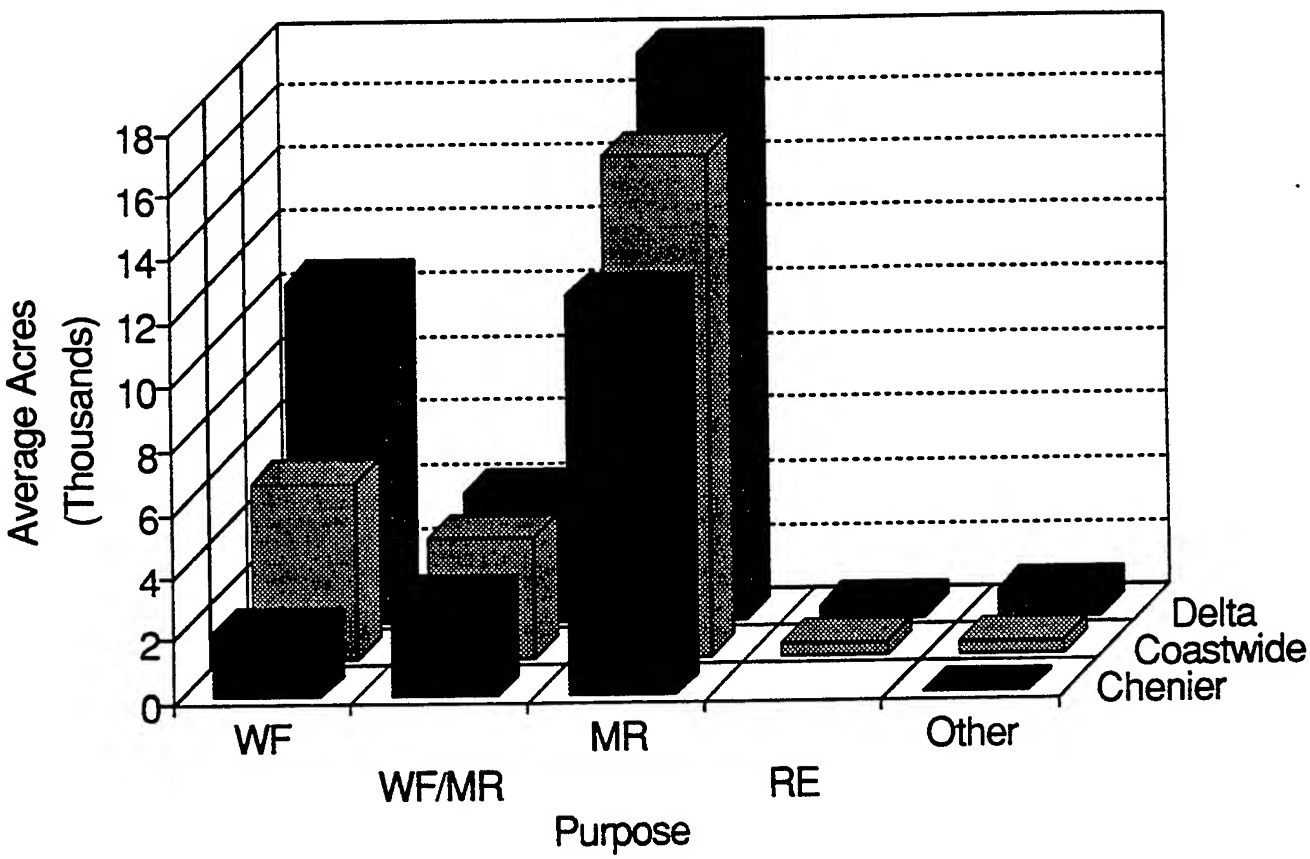


Figure C-15 - Permits: 1977-1995

Avgs: Delta Basins x Purpose

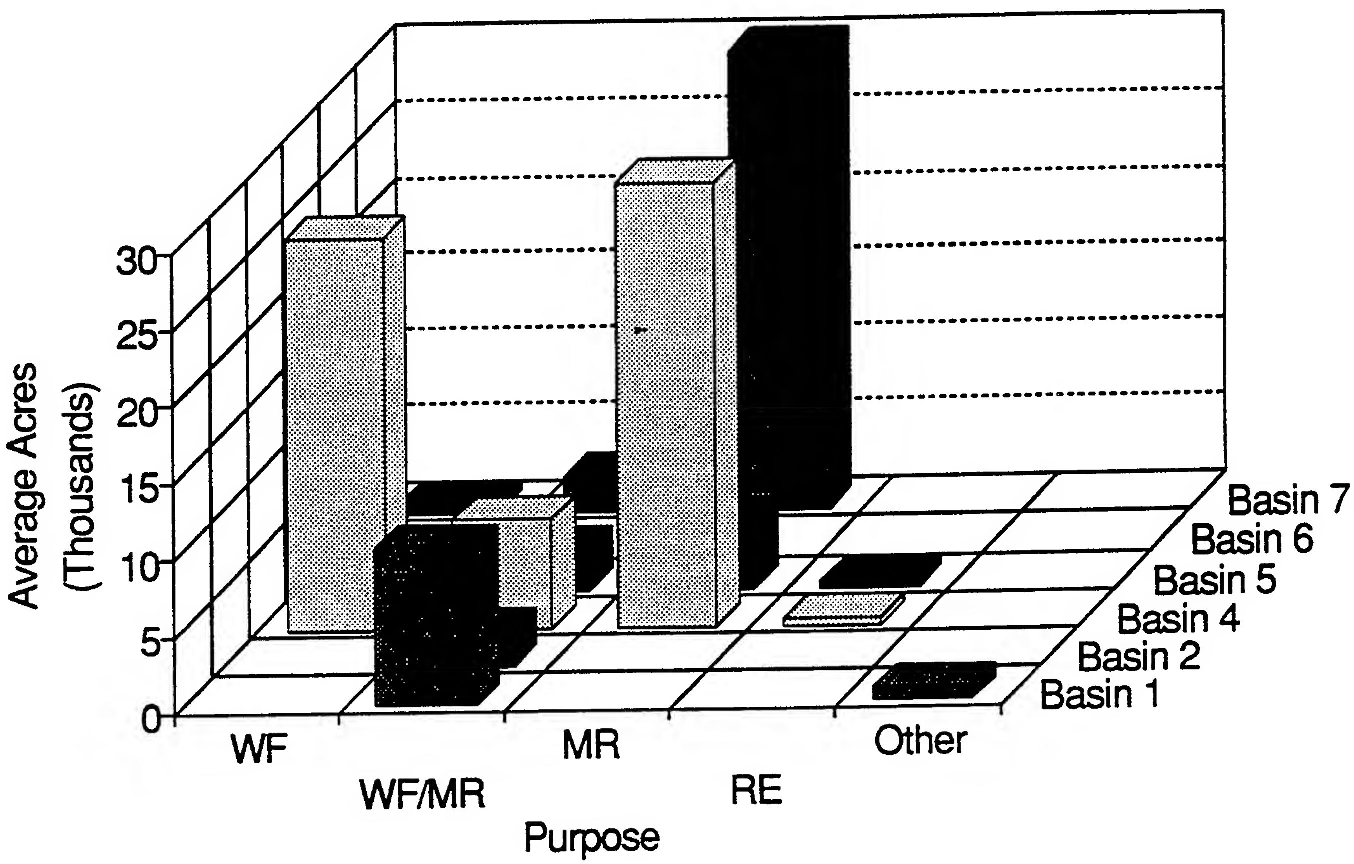
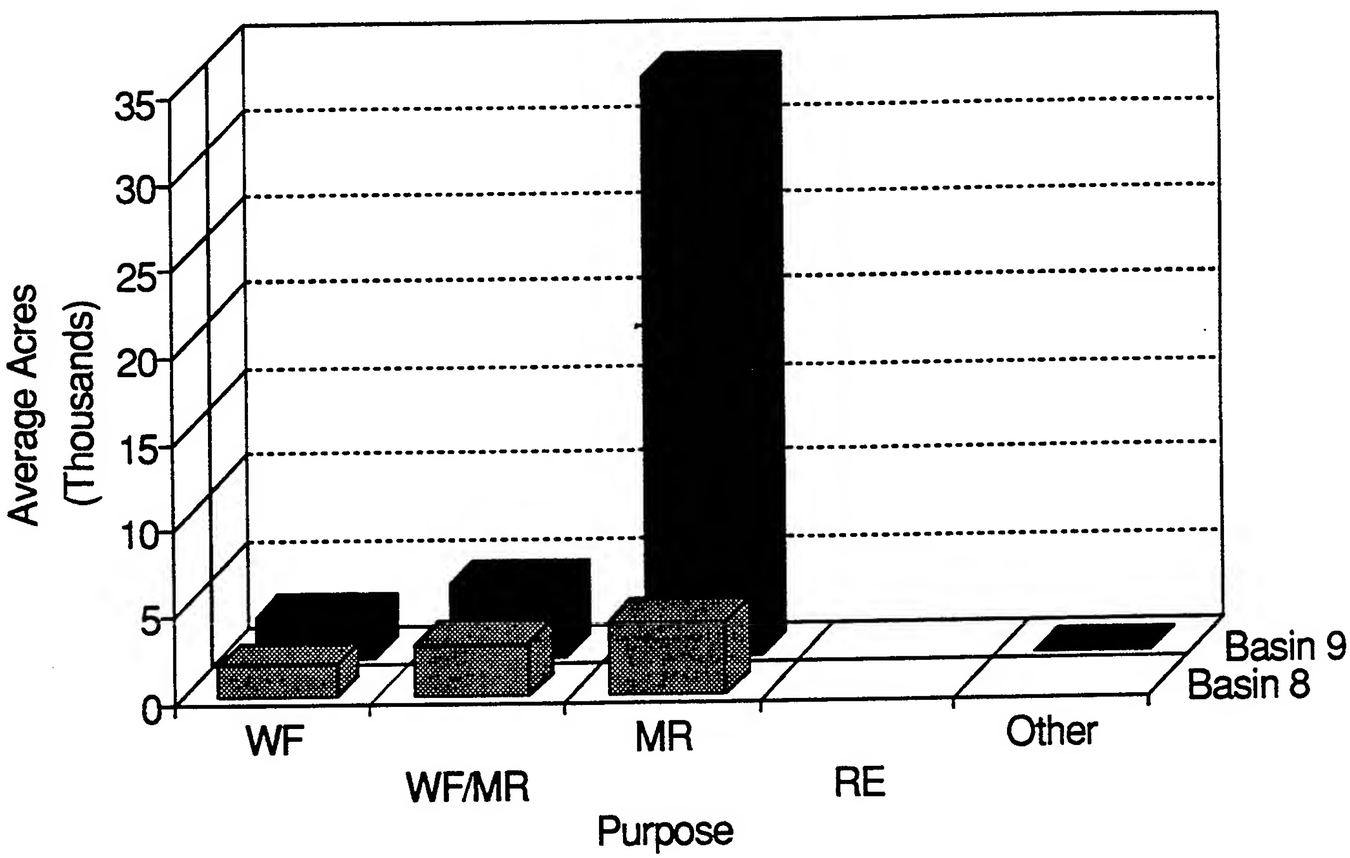


Figure C-16 - Permits: 1977-1995

Avgs: Chenier Basins x Purpose



D - Basin-by-basin Landscape Characterizations

Summary

When considering the location of a marsh management plan to stop, slow, or reverse conversion of land to water, an understanding of how natural physical processes, and man's actions, have interacted to create the current marsh landscape provides insight into future landscape configurations. Specifically, historic land loss trends and probable causes may help identify realistic goals for a project; or determine whether the proposed project is appropriate.

Procedures

Overview

What follows is a general framework within which marsh management/hydrologic restoration plans can be considered relative to past, present and future landscapes in eight of the nine hydrologic units defined by Chabreck, 1972 (Fig. 1). This was accomplished by addressing the following questions: 1) Where, and how much, land loss has occurred since the 1930's?; 2) What is the current land loss trend for each hydrologic unit?; 3) What are the primary probable causes for the observed trends?; and, 4) What is the land loss trend likely to be over the next 20 years?

Introduction

Over the past 7,000 years five major delta complexes have prograded into coastal Louisiana (Figure 2). Progradation of these deltas is responsible for the formation of two distinct geomorphic regions; the deltaic plain in the central and southeastern portions of coastal Louisiana and the chenier plain in the southwestern part of the state. In the deltaic plain, shifting courses of the Mississippi River led to the deposition of sediments over an area of approximately 15,000 square miles (Fisk, 1944; Kolb and Van Lopik, 1958; Frazier, 1967). The end result of this long period of deltaic sedimentation has been the formation of a vast expanse of marsh and swamp separated by abandoned courses and distributaries. In contrast, the chenier plain formed by longshore transport of fine-grained Mississippi River sediments that were deposited to the west of the deltaic plain. These sediments, transported by westward flowing nearshore currents, were eventually deposited along the existing shoreline as mudflats. When deposition ceased or declined due to shifting Mississippi River courses, these deposits were reworked by coastal processes, concentrating the coarse grained sediments, and forming shore-parallel ridges called "cheniers" (Gould and McFarlan, 1959; Byrne et al, 1959). Introduction of new sediment by westward shifts of the Mississippi River delta resulted in the

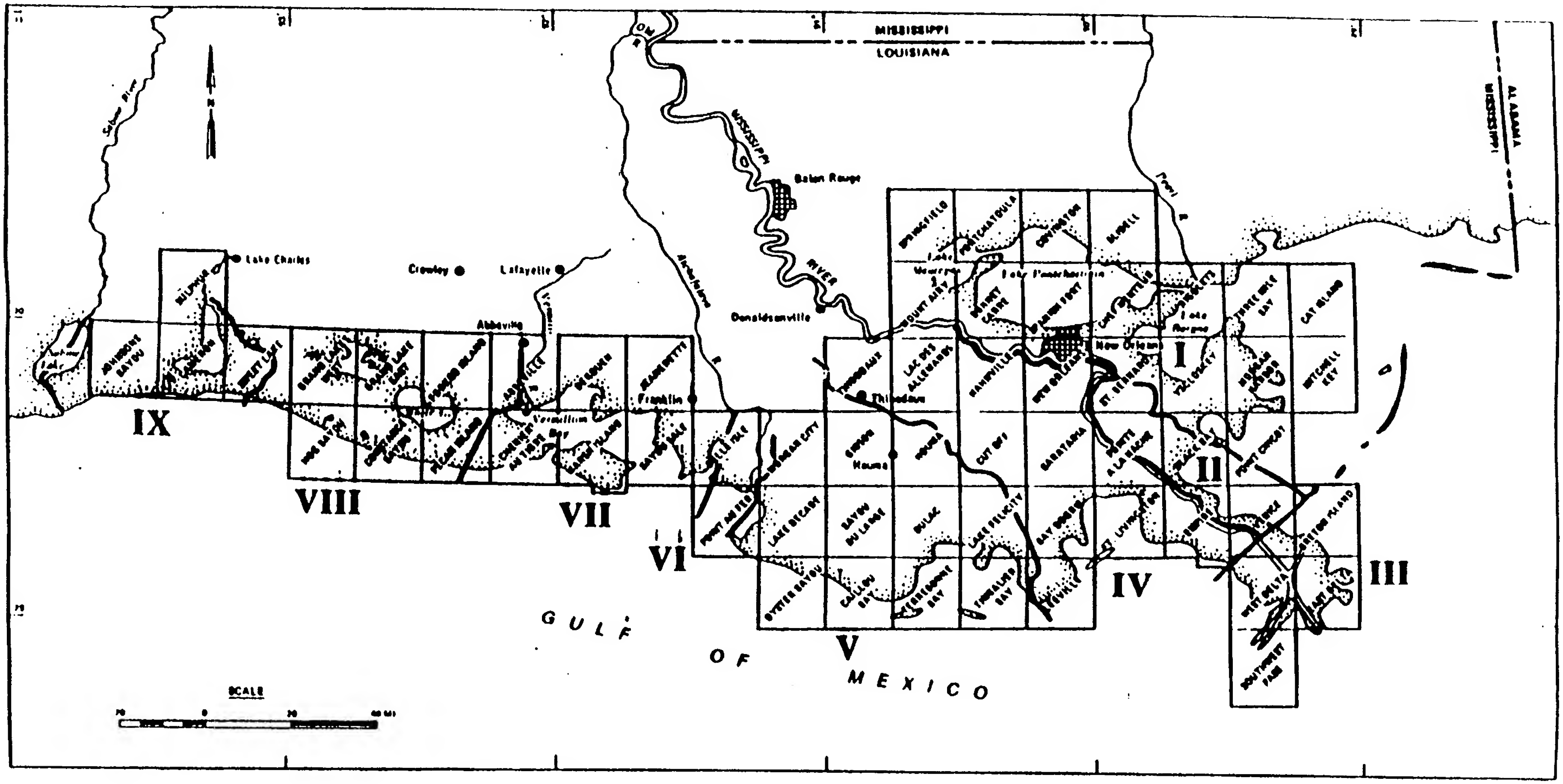


Figure 1. Hydrologic units of the Louisiana coastal marshes.

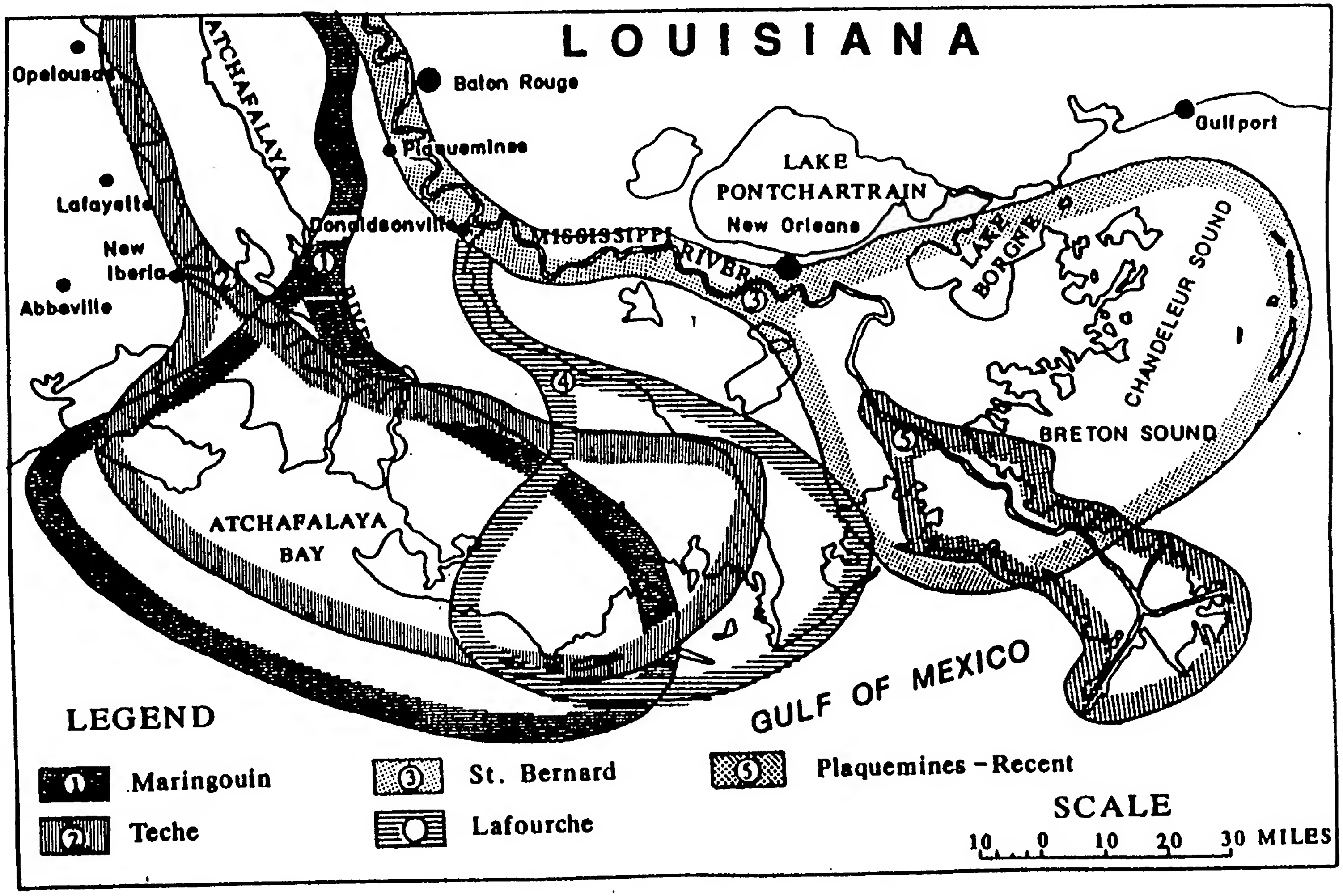


Figure 2. Delta complexes comprising the Mississippi River deltaic plain (from Kolb and Van Lopik 1966)

isolation of these ridges by accretion of new material on the existing shoreline. Numerous cycles of deposition and erosion have been responsible for creating the alternating ridges separated by marshlands which are characteristic of the chenier plain.

Until the early 1900's, land building processes dominated in the Mississippi River deltaic and chenier plains. Since then, this trend of land building has reversed and the Louisiana coastal zone is losing land at a high rate, particularly in the deltaic plain (Turner and Cahoon, 1987; Dunbar et al., 1992). Land loss during the past 60 years is responsible for the destruction of hundreds of square miles of wetlands. Causes for this loss range from man's activities (i.e. canal dredging, channelization of streams, levee construction, and hydrocarbon extraction) to various natural phenomena such as subsidence, wave and current erosion, and subsurface geologic control (Penland et al., 1990).

Land Loss Data Sets

There are two sources of land loss data that encompass the Louisiana coastal zone that can be used for this effort. For the purpose of the PMMEIS the NOD's Geologic Environments and Land Loss (GELL) Geographic Information System (GIS) was used to determine historic land loss trends and predict future loss trends. The basis for that decision is discussed below.

One available data base is the U.S. Fish and Wildlife Service/Louisiana Department of Natural Resources (FWS/DNR) GIS. The other is the GELL GIS system compiled and maintained by the New Orleans District (NOD), Corps of Engineers. A major problem with both GIS data bases is that neither was specifically designed to predict future marsh landscapes. Additionally, they were conceived for different reasons, and track and measure different attributes of the landscape using different techniques at different points in time. Thus, regardless of which GIS was selected, care must be taken in using them to do something they were not specifically designed to do. The choice of one over the other must hinge on other factors. The NOD's data base focuses on measuring reductions of land acreage over time but is also complimented with data on engineering geology, subsidence, and depth to the Pleistocene surface. Land loss acreages have been determined for four time intervals over a continuous period spanning about 60 years (1930's to 1990). The 1930's to 1956/58 time interval in the NOD's data base serves as an historic benchmark against which the relative higher land loss rates observed in the 1960's and 1970's can be evaluated. The FWS/DNR data base focuses on delineating habitat types. This data base currently consists of three temporal data points (1955, 1978, and 1988). Despite the differences, both data bases provide similar estimates of land loss rates and trends for the time period which is common to both. Because NOD's database contains additional

land loss data, as well as data on engineering geology and subsidence which supplement the land loss data for determining causes and future trends of land loss, we chose this database for use in this study.

Calculation of Land Loss

Land loss during each of the four time periods was determined by comparing the 1930's base map with subsequent aerial photographic coverages, and delineating those areas which were land in the 1930's and had become water. Water was classified as any area of water having no permanent vegetation visible at the surface. Permanent vegetation, for purposes of this study, is that which is attached to the substrate, not floating vegetation such as hydrilla and hyacinths. Land was simply defined as everything on the photograph not classified as water. Areas of accretion were not mapped in the Corps study. However, a previous study by the Corps of Engineers (May and Britsch, 1987) showed that except for the modern Mississippi River Delta and the Atchafalaya Delta, land gain throughout most of coastal Louisiana is negligible. Therefore, areas of open water or loss on earlier photographs that subsequently became vegetated were not identified. The land loss data is presented in two ways. One is average square miles of loss per year and the other is average percent of land lost per year. When presented as square miles per year the rate of loss is somewhat independent of the area mapped. Even though the rate is accurate it doesn't fully reflect the physical setting in which the rate of loss is taking place. For example, the average rate of loss may be 1.0 sq mi/yr for a quadrangle located at the coast with a low percentage of land area. The rate of 1.0 sq mi/yr is probably more significant for the quadrangle located on the coast because in terms of the loss rate it represents a much larger percentage of the original land area. When the loss rate is presented in square miles only, this point tends to be lost. Therefore, the land loss rates are also presented as percent lost per year. By converting the loss rate to percent, the data is normalized for the entire coastal area so that regardless of where the area is, it can be compared with another area on an equal basis with regards to loss. This is an important consideration when comparing and contrasting areas relative to land loss rates. The land loss trends determined for each hydrologic unit, combined with historic land use/geologic data provide valuable insight into the causes of land loss within each unit.

Causes of Land Loss:An Overview

There are numerous causes of land loss in coastal Louisiana. Loss is commonly the result of several causes acting together. Relative subsidence has been a major contributor to land loss in coastal Louisiana for thousands of years. Long-term relative subsidence rates in coastal Louisiana range from 0.25 to 5.0 feet

per century. Relative subsidence will continue to be a contributor to the observed land loss in the future. However, since approximately 1960, the land loss rate has increased dramatically, inconsistant with the long term (100's of years) trend of loss. It is the causes of this more recent loss which are the main focus of this write-up. All of the observed losses are occurring on a landscape which is undergoing relative subsidence. To a large extent, the alterations which have been superimposed on this subsiding landscape have led to the recent higher rates of loss. Throughout coastal Louisiana the following three general causes of loss appear to be responsible for a large percentage of the recently observed land loss:

1. Shoreline erosion. Shoreline erosion is loss due to the physical removal of material by wave and current action. Waves are generated by wind action as well as from boat traffic. Shoreline erosion along the coast and lakes is especially severe during the passage of cold fronts and tropical storms. Shoreline erosion is usually greatest on points and along barrier islands where wave energies are focused. Erosion along channels and canals (both natural and man-made) is mainly due to waves and drawdown generated by boat traffic.

2. Altered hydrology. Alterations to the natural surface hydrology result from activities such as the construction of roads, levees, canals, and navigation channels and their relationship with natural geomorphic features. These features commonly restrict surface drainage and tidal exchange by creating areas which are impounded or semi-impounded.

Altered hydrology resulting from impoundments or semi-impoundments has been linked to marsh loss (Turner and Cahoon, 1987; and Scaife, Turner, and Constanza, 1983). Most of the loss caused by alterations to the hydrology is located in the interior wetlands and is referred to as interior land loss. These alterations to the hydrology can result in prolonged periods of elevated water levels relative to areas outside those affected, and in some instances, unnaturally low water levels. The impoundments or semi-impoundments retard movement of water out of the wetlands; especially after heavy rains or flood events leading to a relative rise in water levels. They also restrict flow into the wetlands, blocking nutrients and water during drier periods.

If the water surface elevation is lowered (naturally or artificially) for an extended period of time, the upper organic zone may be dewatered and possibly oxidized resulting in a loss of surface elevation or subsidence. The result will be a relative rise in water level that could negatively impact existing vegetation. The effects of salt water intrusion may increase because storm surges or abnormally high tides that get into the wetlands are retained longer due to the restricted drainage. The overall increase in relative water levels within many of these impounded or semi-impounded areas also increases

the the physical removal of material by wave and current action. Because water levels are elevated, more surface area is exposed to erosion.

Another consequence of altered hydrology may be an increase in tidal exchange and drainage resulting from canals and waterways that are dredged into previously isolated wetlands. This may lead to tidal scour and salt water intrusion which contributes to land loss.

Land loss resulting from altered hydrology is usually due to a combination of the impacts listed above.

3. Direct man-made loss. This is loss from dredging related activities such as navigational waterways, oil and gas exploration, borrow pits and canals, aquaculture and disposal ponds, and drainage canals.

Unit 1

Location

Hydrologic Unit 1 encompasses the Lake Maurepas, Lake Pontchartrain, and Lake Borgne drainage systems. The Unit is bounded by the Pleistocene Terraces on the North and West and extends eastward to the Chandeleur Islands. The southern boundary begins at Breton Island and runs northwest to Mozambique Point, then northwest up Bayou Terre Aux Boeufs to the town of Delacroix, then north up Louisiana Highway 300 to Reggio and west along Hwy 46 to Poydras and the Mississippi River. The boundary then follows the Mississippi River to Donaldsonville (Fig. 1).

Geologic Setting

Unit 1 is located in the extreme northeastern portion of the Mississippi River deltaic plain. This Unit is generally comprised of inland swamp and brackish marsh in the western portion, brackish marsh in the central portion and brackish and saline marsh in the eastern portion. Dominant physiographic features include the Mississippi River and its associated natural levee, Lakes Maurepas, Pontchartrain, and Borgne, the Mississippi River Gulf Outlet, and the numerous abandoned distributaries related to past delta development. Elevations in the unit range from +15 feet NGVD on the natural levees bordering the Mississippi River to near 0 feet NGVD in the coastal marshes.

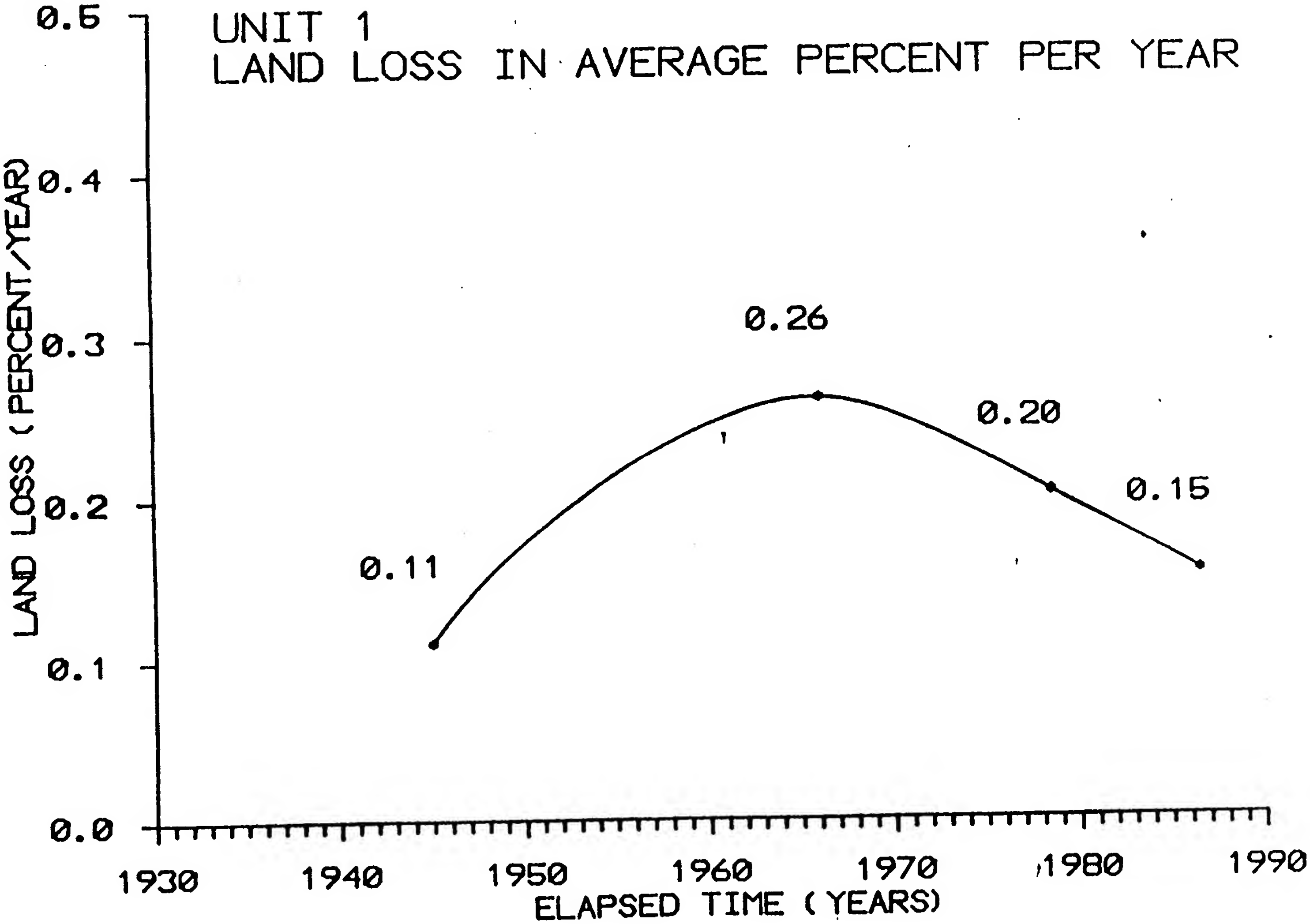
Typical geologic profiles in the area show characteristic depositional environments of the deltaic plain. The Holocene sediments are relatively thin (<25 feet) in the extreme western portion of Unit 1 and thicken gradually to approximately 180 feet in Chandeleur Sound. The surface and shallow subsurface environments are composed of swamp and marsh deposits separated

by abandoned distributaries. Marsh deposits are composed of organic clays and peats. Swamp deposits are generally soft to medium clay with minor amounts of silt and organics. Natural levee deposits are oxidized, medium to firm clays and silt, having lower water content and higher compressive strengths than the surrounding environments making them less susceptible to erosion. Beneath the marsh, swamp, and natural levee deposits are interdistributary deposits ranging from 10 feet thick in the western portion of the Unit to 40 feet thick in the eastern portion. Interdistributary deposits are composed of very soft clays with minor amounts of silt. Prodelta deposits underlie interdistributary deposits and range from 5 feet thick in the western portion of Unit 1 to 100 feet thick in Chandeleur Sound. They are composed of medium clays with minor amounts of silt. Below the prodelta deposits are nearshore gulf deposits. They are approximately 5 feet thick, and are composed of silts, sands, and shell. Nearshore gulf deposits lie unconformably on the Pleistocene surface.

The Pleistocene surface outcrops west of Lake Maurepas and north of Lake Pontchartrain. It is located at approximately -25 feet NGVD below Lake Maurepas, -50 feet NGVD below Lake Pontchartrain, -50 feet NGVD near Chef Menteur, -80 feet NGVD near Shell Beach, -135 feet NGVD near Point Chicot, and -180 feet NGVD in Chandeleur Sound. Pleistocene deposits are generally very stiff, oxidized clays with low water content and high compressive strengths. The Pleistocene represents the most stable surface in coastal Louisiana with regards to subsidence. Generally, where the depth to the Pleistocene is shallow (<50 feet), subsidence rates are relatively low. The relatively shallow depth to the Pleistocene surface in the western half of Unit 1 is largely responsible for the relatively low subsidence rates in this area. Long-term, relative subsidence rates for the western portion of Unit 1 average approximately 0.4 feet/century. The depth to the Pleistocene surface gradually increases eastward until it reaches approximately -180 feet NGVD in Chandeleur Sound. Average subsidence rates in the eastern half of Unit 1 are over 0.5 feet/century. Because most of the sediments in Unit 1 were deposited by the St. Bernard Delta which became active approximately 4000 years before present, the rapid subsidence associated with more recent deltaic deposits has already taken place. Therefore, Unit 1 does not exhibit the higher subsidence rates common in more recent deltas in the deltaic plain.

Historic Land Loss

The average yearly land loss rate for Unit 1 was 1.59 square miles for the 1932 to 1958 period. The rate almost doubled to 3.52 sq mi/yr during the 1958 to 1974 period. The rate decreased to 2.58 sq mi/yr for the 1974 to 1983 period and continued to decrease to 1.92 sq mi/yr for the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend. The percentage loss rate peaked at 0.26 percent per


UNIT 1
LAND LOSS IN AVERAGE PERCENT PER YEAR
0.11
0.26
0.20
0.15
0.5
0.4
0.3
0.2
0.1
0.0
LAND LOSS (PERCENT/YEAR)
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

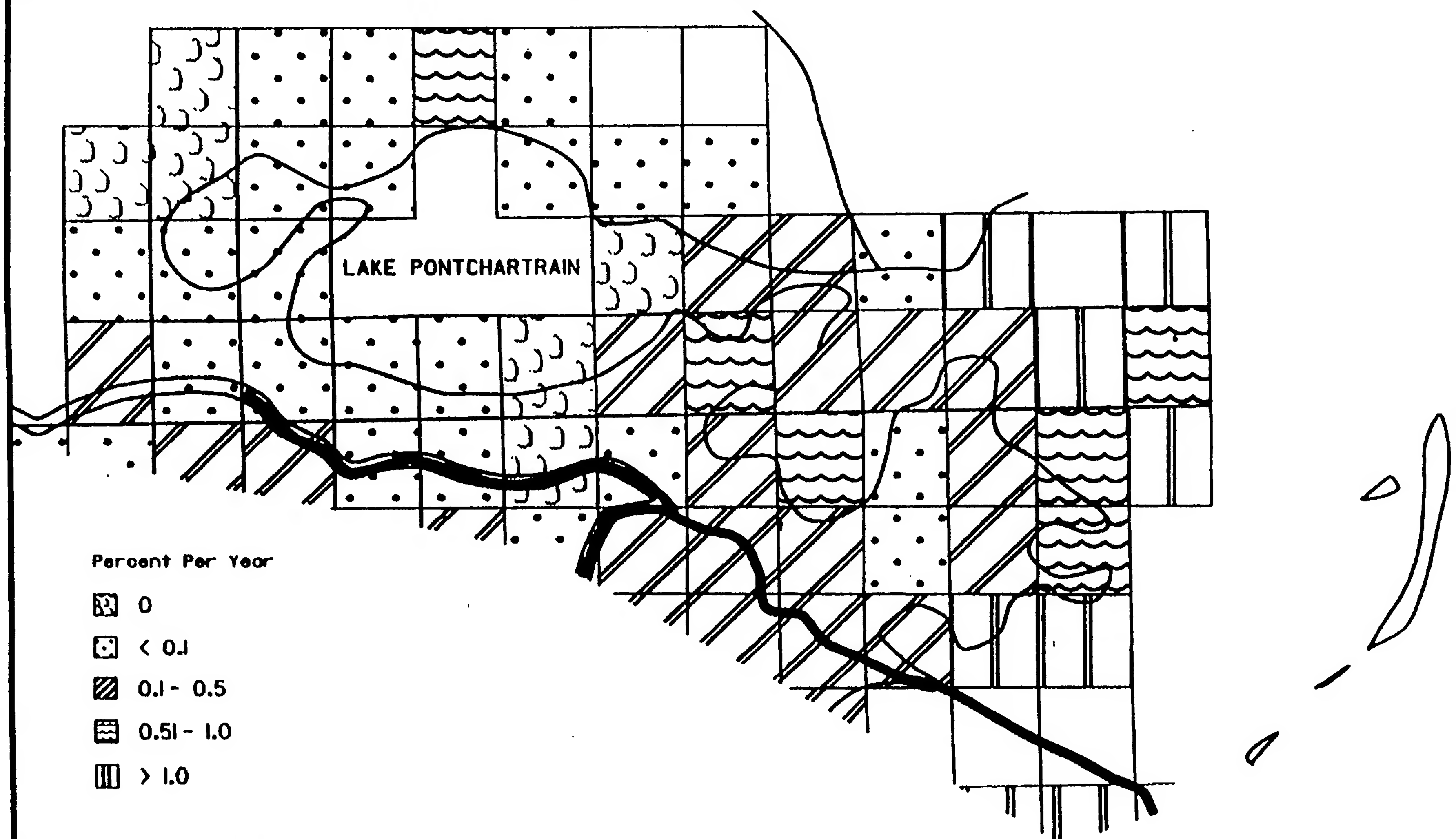


Figure 4. Average annualpercentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

year during the 1958 to 1974 period. It began to decrease after 1974, and was 0.15 percent per year during the 1983 to 1990 period (Figure 3). By 1990, Unit 1 had lost approximately 10 percent of the land area present in 1932. As shown in Figure 3, the highest loss rate occurred during the 1958 to 1974 period which is common for most of coastal Louisiana. Direct man-made loss accounted for approximately 17 percent of the total loss from 1932 to 1990. Over half of the direct man-made loss occurred during the 1958 to 1974 period. Figure 4 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey (USGS) quadrangles approximating Unit 1. This figure shows that the western portion of Unit 1 is generally losing less than 0.1 percent of its land area each year. The central portion is losing between 0.1 and 0.5 percent per year, and the eastern portion is losing 0.1 to over 1.0 percent per year.

Location of Historic Loss

Following are lists of areas which have experienced relatively high loss rates. These lists do not include all possible sites, but they do identify many areas which have experienced high land loss throughout Unit 1.

Some areas which have experienced relatively high rates of interior marsh loss in Unit 1 include:

1. north and south of Interstate 10 near Labranche
2. approximately 3 miles west of Madisonville, north of the Lake Pontchartrain shoreline
3. south of Lacombe between the Pleistocene Terrace and the Lake Pontchartrain shoreline
4. within the Bayou Savage Refuge
5. north and south of Bayou Bienvenue between the Intracoastal Waterway and the Mississippi River
6. the Fritchie marsh, north of the Rigolets
7. east of Bayou Terre aux Boeufs between Reggio and Delacroix
8. between Hwy 11 and Bayou Bonfouca
9. just west of Paris road south of Bayou Bienvenue

Some areas where shoreline erosion rates have been especially high include:

1. the south shoreline of Lake Maurepas
2. the shoreline north and south of Pass Manchac in Lake Pontchartrain
3. the southwest shoreline of Lake Pontchartrain
4. the shoreline of Lake Pontchartrain just west of Chef Menteur Pass
5. Goose Point on the north shore of Lake Pontchartrain
6. Alligator, Shell, and Proctor Points and Point aux Marchettes in Lake Borgne
7. the southeast and southwest shoreline of Lake Borgne

8. the north bank of the Mississippi River Gulf Outlet

9. La Petit Pass Island, Grand Island, and Isle Au Pitre in Mississippi Sound

10. Door Point, Brush, Martin, and Comfort Islands, and Mitchell Key in Chandeleur Sound

11. Deadman, Grace, Mozambique, and Gardner Points and Point Chicot in Breton Sound

Some sites where direct man-made loss has been relatively high include:

1. the Mississippi River Gulf Outlet
2. the Gulf Intracoastal Waterway
3. the borrow areas for Interstate 55
4. the Inner Harbor Navigation Channel

The approximate date, location, and morphology of the land loss provides insight into the major causes of loss. From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) for the Pontchartrain Basin, the primary causes of historic land loss in Unit I appear to be shoreline erosion, alterations to the natural surface hydrology, and direct man-made loss from dredging.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased significantly since the 1958 to 1974 period. The main reason for this decrease was the reduction in interior marsh loss since 1974. Since 1974 a larger percentage of land loss in Unit 1 has been due to shoreline erosion.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. the shorelines of Lake Pontchartrain, Lake Borgne, Mississippi Sound, Chandeleur Sound, and Breton Sound; especially where the shoreline protrudes into these open water areas. The shorelines of Breton and Chandeleur Sounds are most vulnerable because they receive the highest energy waves and currents

2. the interior marshes north and south of Bayou Savage and in the Fritchie marsh where altered hydrology continues to cause marsh loss

3. the north bank of the Mississippi River Gulf Outlet; especially where the bank intersects small ponds and bays

4. south of Lacombe between the Pleistocene terrace and the Lake Pontchartrain shoreline

5. the shoreline of Lake Pontchartrain just west of Chef Menteur Pass

6. between Hwy 11 and Bayou Bonfouca

In the areas identified in 2, 4, and 6, alterations to the hydrology will likely be responsible for future losses.

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. Areas where the eroding lake shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from the large lakes to act directly on previously protected interior marshes. This has or will likely occur at the following locations:

a. near Pt aux Herbes in Lake Ponchartrain

b. in the vicinity of Goose Point on the north shore of Lake Ponchartrain

c. about 4 miles south of Pass Manchac

d. on Proctor Point in Lake Borgne

e. the shoreline bordering the numerous lakes and small bays in the marshes adjacent to Mississippi, Chandeleur, and Breton Sounds where the shoreline has eroded or will erode into these areas

The direct man-made loss due to dredging activity in Unit 1 has decreased since 1974 and will probably continue to decrease.

Permits

Six marsh management permits have been issued within Unit 1 (see Figure ?). Waterfowl management/marsh restoration are the primary purposes stated for these projects. The major structural elements of these projects are water control structures.

Only #156-A and a portion of #65 have experienced high rates of land loss in the past 60 years. All the permitted projects generally focus on water level control and prevention/reduction of salt water intrusion as actions intended to benefit marsh growth and help prevent future loss of these areas. However, only at #156-A, and some of the lake shoreline on #65 does significant land loss seem imminent. A review of land loss, subsidence, and geologic/geomorphic data from several time periods suggest that high relative water levels in the area south of the railroad on #156-A have contributed to past land loss. Thus, projects designed to affect relative water levels in this area may prove effective at reducing loss rates. Shoreline erosion on the Lake Borgne side of #65 may cause the shoreline to intersect isolated ponds of the interior marshes exposing them to lake processes and increased erosion. Five of the six previously permitted projects are wholly or partially contained on the CWPPRA list of proposed projects.

CWPPRA

The restoration plan developed under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) for the Pontchartrain Basin summarized the existing conditions, identified the problem areas for the Basin, and proposed projects to address these problem areas. The Pontchartrain Basin closely approximates Hydrologic Unit 1 as defined by Chabreck, 1972. As summarized from CWPPRA, the primary causes of wetland loss in the Pontchartrain Basin are the interrelated effects of relative subsidence, erosion, saltwater intrusion, and human activities. The most significant human activity was the construction of the Mississippi River levees which eliminated fluvial processes that nourished wetlands with fresh water and sediment. Other significant human activities include the filling, draining, flooding, or dredging of wetlands, and the saltwater intrusion, direct construction impacts, and erosion associated with the MRGO.

The 4 critical problems identified in the restoration plan are: 1) increased salinity and reduced sediment and nutrient input, 2) MRGO bank erosion, 3) possible loss of land bridges, and 4) possible loss of critical areas where marsh loss is imminent. Figure ? shows the location of the proposed marsh management projects in Unit 1 from the CWPPRA Plan. Five of these projects have been partially or wholly permitted and are discussed somewhat under "Permits".

The area covered by proposed projects PO-6, PO-9A, XPO-52A, and XPO-52B have experienced considerable interior marsh loss in the past 60 years. However, in the previously permitted portion of PO-9A, minimal historic loss has occurred. PO-6 and PO-9A both involve introduction of fresh water and some sediments which will benefit these areas assuming that the water can be directed through the marshes. However, at PO-6, historic land loss data suggests that relative water level rise may have contributed to marsh loss. Therefore, any project designed to increase water flow into this area should address how excess water will be removed.

Marsh loss at XPO-52A&B appears to be the result of relative water level rise. Thus, removal of excess water should reduce future loss in these areas.

Land loss in the areas covered by projects XPO-51, PPO-19, and PO-15 has been relatively minimal over the past 60 years except for relatively high rates of shoreline erosion along the lake shorelines and an area of interior marsh loss in PPO-19. Shoreline erosion rates are expected to remain approximately the same over the next 20 years except where the shoreline breaks through to interior ponds exposing easily erodable material to lake processes. Measures to reduce shoreline erosion in these areas may prevent the lake shore from intersecting interior ponds, thereby reducing loss rates.

The project area of XPO-84 has experienced relatively little land loss since 1932. What loss has occurred is mainly shoreline erosion around existing ponds. This shoreline erosion is expected to continue.

The area covered by XPO-71 is part of the MRGO disposal area and is dependent on levees and culverts to maintain water levels. If this area is to continue as a marsh, water control devices will have to be maintained.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that specifically address the areas of past and anticipated future loss listed above under "Location of Historic Loss" and "Future Areas of Loss".

The CWPPRA Plan estimates that nearly 24,960 acres (9%) of the Basin's existing marshes will be converted to open water in the next 20 years without implementation of proposed projects, with losses concentrated in the middle and lower basin and on the land bridges. Approximately 32,800 acres of swamp are projected to be lost in 20 years on the Pontchartrain/Maurepas land bridge and in the middle basin. The majority of the swamp acreage will convert to marsh. The CWPPRA land loss projections were made by applying the land loss rate determined for the 1974 to 1990 period to the 1990 land area and extrapolating it to 2010. This method of projection may be appropriate when estimating loss over the entire Basin, but should be avoided for site specific areas which are dynamic with respect to land loss.

<u>Summary</u>

In summary, both the square miles and percentage of land being lost annually in Unit I has decreased significantly since the 1958 to 1974 period. The main reason for this decrease was the reduction in the amount of interior marsh loss since 1974. Since 1974, an increasing percentage of land loss appears to be related to shoreline erosion. As shown in Figure 4, during the 1983 to 1990 period the western portion of Unit I generally lost less than 0.1 percent of its land area each year. The central portion generally lost between 0.1 and 0.5 percent per year, and the eastern portion lost from 0.1 to greater than 1.0 percent per year. The high percentage loss rates in the eastern portion of Unit I is mainly the result of high rates of shoreline erosion due to high energy waves and currents in the vicinity of Breton, Chandeleur, and Mississippi Sounds.

The overall rate of loss in Unit I should remain relatively constant over the next 20 years assumming interior marsh loss and direct man-made loss remain low. Shoreline erosion will likely continue to be a dominant cause of loss in this Unit. Each proposed project should be analyzed to document/verify active and/or projected causes of loss. This will help to insure that the proposed solution matches the perceived problem, resulting in a viable project.

Unit 2

Location

The northern bounbary of Unit 2 follows the southern boundary of Unit 1 from Breton Island to the Mississippi River. It then follows the Mississippi River downstream to a point approximately 2 miles south of Boothville. The boundary then turns northeast to Breton Island (Fig. 1).

Geologic Setting

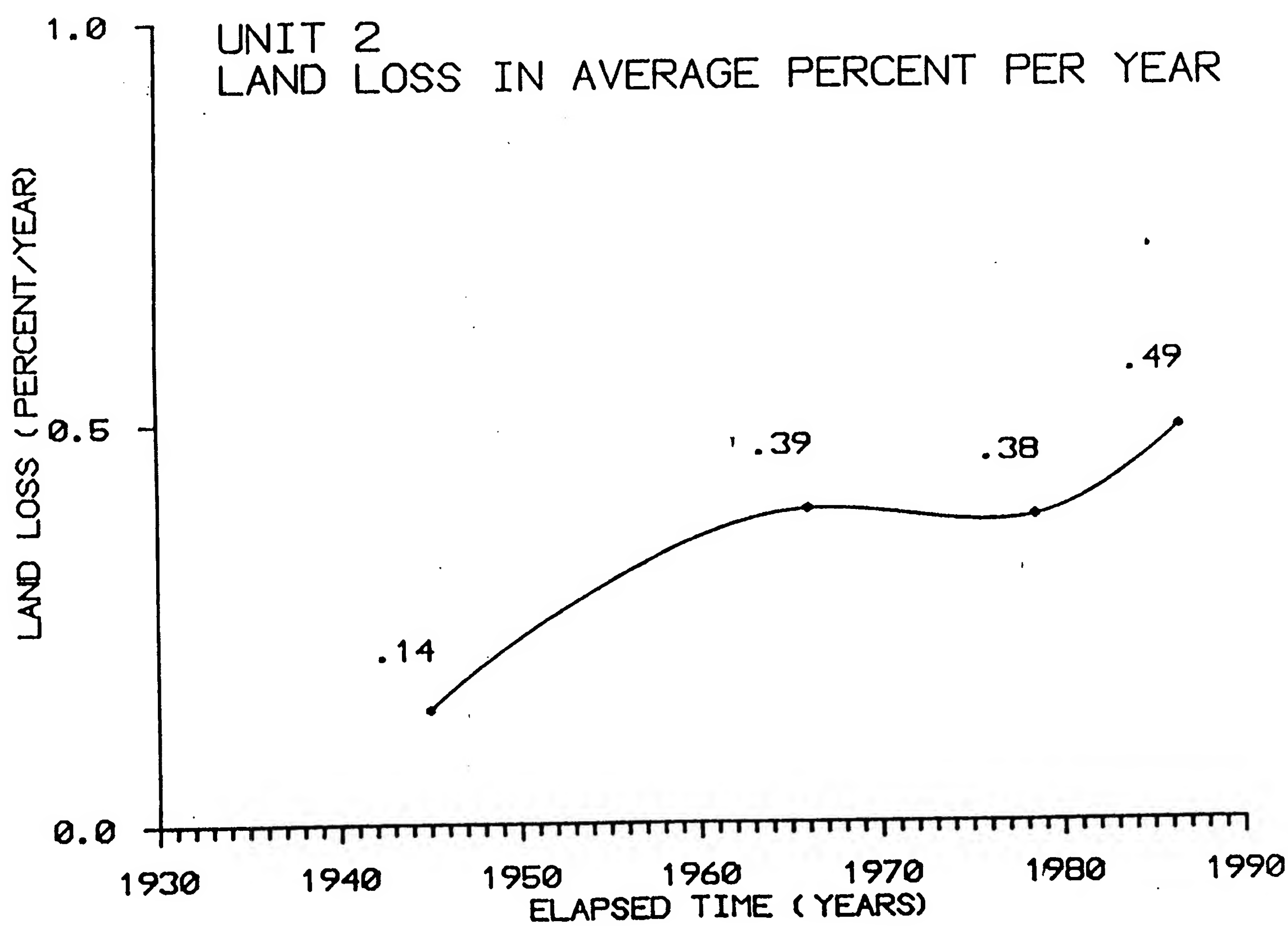
Unit 2 is located in the eastern portion of the Mississippi River deltaic plain. This Unit is comprised of brackish marshes in the western half and saline marshes in the eastern half. Dominant physiographic features include the natural levee of the Mississippi River, abandoned distributaries and their associated natural levees, Grand Lake and Lake Lery. Elevations range from approximately +5 feet NGVD on the natural levee bordering the Mississippi River to near 0 feet NGVD in the most seaward marshes.

Geologic profiles in the area show typical depositional environments of the deltaic plain. The upper Holocene sediments range from 100 feet thick near the Mississippi River to approximately 200 feet thick near Breton Island. Holocene sediments are composed of numerous abandoned distributaries and their associated natural levees separated by marsh deposits. Natural levee deposits are composed of oxidized clay and silty clay with minor amounts of silt and are up to 15 feet thick. Natural levees generally have higher compressive strengths and lower water contents than the surrounding environments making them less susceptable to erosion. Marsh deposits are composed of organic clays and peat having high water contents and obtain thicknesses of up to 12 feet. Natural levee and marsh deposits are underlain by interdistributary deposits composed of soft to very soft clays with minor amounts of silt having high water content. Interdistributary deposits range from 60 to 100 feet thick in Unit 2 and are underlain by prodelta deposits. Prodelta deposits are composed of medium clays with minor amounts of silt and range from 60 to 70 feet in thickness. Beneath the prodelta are nearshore gulf deposits approximately 10 feet thick composed of silts, sands, and shell. The Pleistocene surface underlies the nearshore gulf deposits. The depth to the Pleistocene ranges from approximately -100 feet NGVD near the Mississippi River to approximately -200 feet NGVD in the vicinity of Breton Island.

Long-term relative subsidence rates in Unit 2 average approximately 0.75 feet per century with rates of up to 4.0 feet per century in the extreme southwestern portion of the Unit.

Historic Land Loss

The overall trend in land loss in Unit 2 since 1932 has been one of increasing rates. During the 1932 to 1958 period the


UNIT 2
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
.14
.39
.38
.49
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

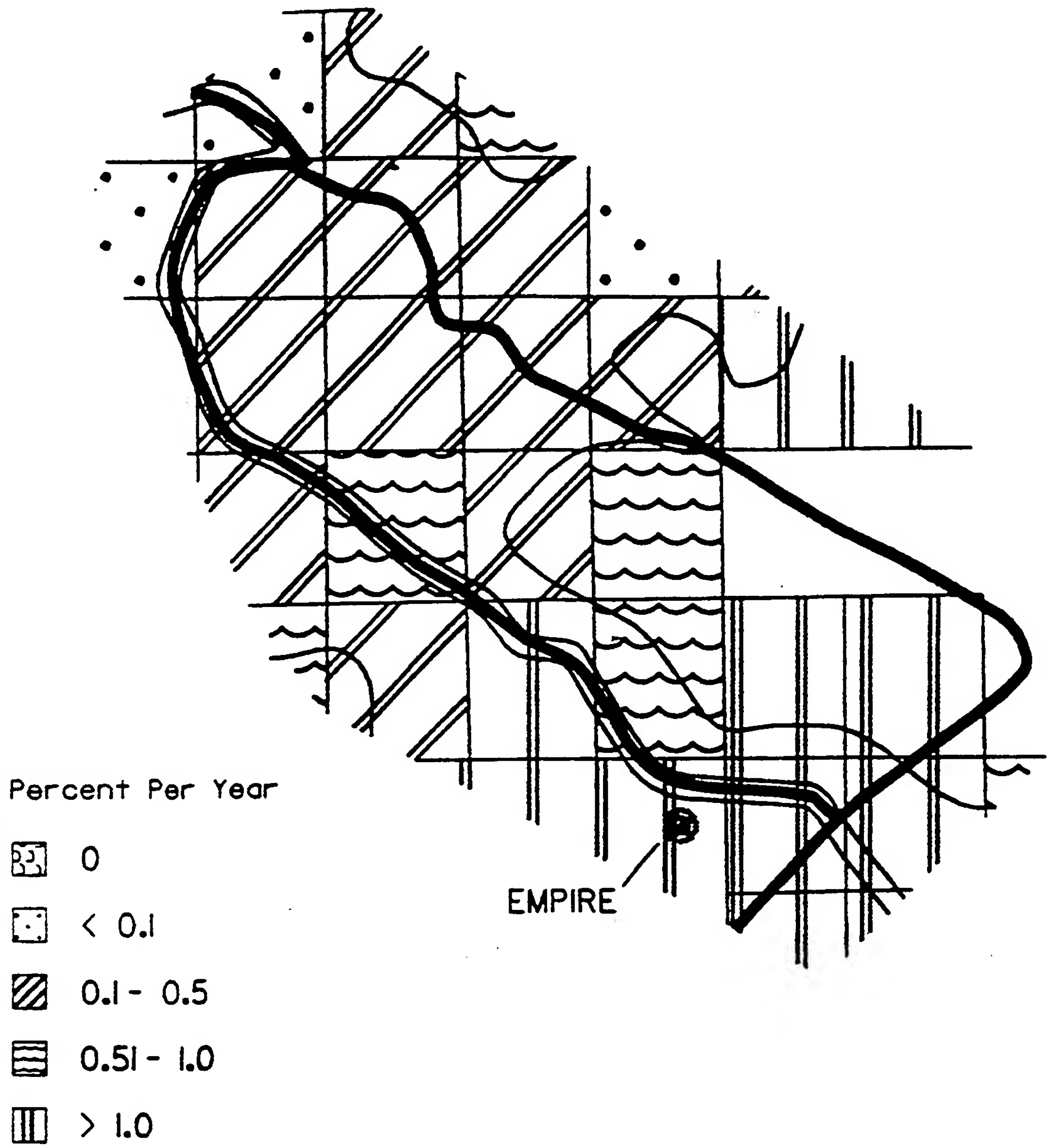


Figure 6. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

average annual land loss rate was 0.47 sq mi/yr. The rate increased to 1.25 sq mi/yr during the 1958 to 1974 period. The rate decreased slightly to 1.15 sq mi/yr during the 1974 to 1983 period but continued its long-term trend by increasing to 1.43 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 5). During the 1932 to 1958 period Unit 2 lost an average of 0.14 percent of its land area each year. This rate increased to 0.49 percent per year during the 1983 to 1990 period. By 1990 Unit 2 had lost approximately 16 percent of the land area present in 1932. Approximately 17 percent of the total loss was classified as direct man-made loss. Most of the direct man-made loss (87 percent) occurred between 1932 and 1974.

Figure 6 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles approximating Unit 2. This figure shows that percentage loss rates are relatively low in the northwestern portion of Unit 2 and increase to over 1 percent per year in the marshes bordering Breton Sound.

<u>Location of Historic Loss</u>

Some areas which have experienced high rates of interior marsh loss in Unit 2 include:

1. the marshes approximately 2 miles east and parallel to the Mississippi River between Braithwaite and Bertrandville
2. approximately 2 miles north and parallel to the Mississippi River near Nero
3. between Bay Denesse and Little Coquille Bay, north of Fort St. Philip

Some areas where shoreline erosion rates have been especially high include:

1. the southern and eastern shore of Lake Lery
2. the southeastern shore of Grand Lake
3. all of the islands located in Black Bay and Breton Sound
4. California and Spanish Points near California Bay
5. Sable Island, Raccoon, Fort, Coquille, and Deepwater Points, and Bird Island adjacent to Breton Sound.

Some sites where direct man-made loss has been relatively high include:

1. the marshes surrounding Lake Petit
2. the area due north of Pointe A La Hache
3. adjacent to the Mississippi River near Fort St. Philip

The available data suggests that the primary causes of land loss in Unit 2 are shoreline erosion, alterations to the natural surface hydrology, and direct man-made loss.

<u>Future Areas of Loss</u>

As shown previously, both the average square miles and percentage of land being lost each year has generally continued to increase during the 1932 to 1990 period. The overall rate of loss within Unit 2 should continue to increase slightly in the near future due to continued high loss related to shoreline erosion. However, at some point in the future, as the eroding shoreline moves inland, it will encounter a greater percentage of the more resistant natural levee deposits possibly resulting in a reduction in the shoreline erosion rate.

Some areas where lands loss rates will remain relatively high or increase slightly include:

1. The marsh shorelines bordering Black Bay and Breton Sound, especially where the shoreline protrudes into open water areas. At these points, wave and current energy is focused resulting in higher relative shoreline erosion rates.
2. The interior marshes approximately 2 miles east and parallel to the Mississippi River between Braithwaite and Bertrandville, and another area between the northeastern shore of Lake Lery and Bayou Terre Aux Boeufs. Altered surface hydrology appears to be responsible for much of the loss in both of these areas.
3. The marshes between Bay Denesse and Little Coquille Bay north of Fort St. Philip. High subsidence rates, shoreline erosion, and numerous man-made canals have all contributed to the high loss rates in this area.

Some areas where land loss rates have been relatively low but may increase are:

1. Sites where eroding lake or bay shorelines intersect isolated ponds or lakes in the adjacent marshes. This allows waves and currents to act directly on previously protected interior marshes. Grand Lake and Lake Petit located in the central portion of Unit 2 are examples of this situation.
2. Areas where man's activities combine with natural features to alter the surface hydrology possibly making them susceptible to marsh loss. One such area is located between Carlisle and River Aux Chenes near the Mississippi River. Their are numerous canals and levees (both man-made and natural) which appear to have altered the surface hydrology in this area. Land loss is already occurring within this area and may increase in the future.

Direct man-made loss in Unit 2 has decreased since 1974 and will probably continue to decrease.

<u>Permits</u>

Four permits for marsh restoration have been issued within Unit 2 (see figure ?). As shown in figure ? the permitted areas

for permits 1, 2, and 48 are contiguous with each other. All three of the permitted areas have experienced relatively high rates of interior marsh loss between 1958 and 1974. Since 1974 the loss rate appears to have decreased except for the area covered by permit 48 where loss continues at a high rate. Land loss, subsidence, and geomorphic data suggests that alterations to the natural hydrology have contributed to the loss experienced in these areas. Several man-made canals and natural levees associated with abandoned distributaries have combined to alter the natural hydrology of these areas. Therefore, any projects designed for marsh restoration in these areas should consider the role which alterations to the natural hydrology have played in marsh loss. The fourth permitted area, #282, has experienced relatively high rates of land loss since 1958. Like the other permitted areas, man-made canals and the natural levees of the Mississippi River and River Aux Chenes have combined to alter the hydrology of this area contributing to land loss.

The three permitted areas in the northern portion of Unit 2 are wholly contained by a project proposed under CWPPRA. The stated purpose of the CWPPRA project is outfall management of storm water runoff pumped from the Forty Arpent Canal on the northern boundary of the area.

CWPPRA

The restoration plan developed under the CWPPRA for the Breton Basin summarized the existing conditions, identified the problem areas in the Basin, and proposed projects to address the problem areas. The Breton Basin closely approximates Unit 2 as defined by Chabreck, 1972.

As summarized from CWPPRA, the two major wetland problems resulting from natural processes and man's activities in the Basin are sediment deprivation and saltwater intrusion. Subsidence and shoreline erosion are important contributors to marsh loss in the lower Basin. Specific strategies for this Basin include managing existing freshwater diversions, building new large scale sediment diversions, rebuilding natural levee ridges, and creating artificial barriers.

There are no projects classified as marsh management proposed in the CWPPRA Plan. However, many of the projects proposed by CWPPRA would benefit many of the areas of loss mentioned previously.

The CWPPRA Plan estimates that approximately 13,380 acres (7.3%) of the Basin's existing marshes will be lost over the next 20 years without implementation of proposed projects. Much of the projected loss is anticipated to occur in the southern half of the Basin.

Summary

The average square miles and percentage of land being lost each year has generally continued to increase since 1932. Loss

rates are especially high in the southern half of this Unit where over 1 percent of the land area is lost annually at some locations. The overall rate of loss in Unit 2 should remain the same or increase slightly in the next 20 years. Shoreline erosion, alterations to the natural hydrology, and subsidence will continue to major contributors to future loss.

Unit 4

Location

Unit 4 encompasses the Barataria Basin and extends from the Mississippi River southward to the Gulf of Mexico. It has common boundaries with four other hydrologic units. It borders Unit 1 along its northern side, Unit 2 along its eastern side, Unit 3 at its southeastern corner, and Unit 5 along the western side (Fig. 1).

Geologic Setting

Unit 4 is located in the central and southeastern portion of the Mississippi River Deltaic Plain. Inland swamp is common in the northern half of Unit 4 bordering the Mississippi River, Bayou Lafourche, and some of the larger abandoned distributaries. The northern half of the Unit also contains fresh and intermediate marsh. Much of this marsh is of the floating variety. Brackish and saline marshes make up the southern half of the Unit.

Dominant physiographic features include the Mississippi River, Bayous Lafourche, L'ours, des Allemands, des Familles, and Grande Cheniere and their associated natural levees. Also, the Barataria Waterway, Grand Isle, Grand Terre Islands, and numerous inland lakes such as des Allemands, Cataouatche, Salvador, and Little Lake. Elevations in Unit 4 range from approximately +10 feet NGVD on the natural levee bordering Bayou Lafourche, to +5 feet NGVD on Grand Isle to near 0 feet NGVD in the coastal marshes.

Typical geologic profiles in this Unit show the characteristic depositional environments of the deltaic plain. The upper Holocene sediments are relatively thin in the northern portion of this Unit and gradually increase in thickness towards the Gulf. Near Lac Des Allemands, Holocene sediments are approximately 50 feet thick and increase to approximately 350 feet thick near Leeville. The upper Holocene depositional environments include numerous abandoned distributaries and their associated natural levees separated by interdistributary, marsh,

and swamp deposits. Natural levees are generally composed of oxidized clay and silty clay having higher compressive strengths and lower water contents than the surrounding environments. Marsh deposits are composed of organic clays and minor amounts of silt, containing high amounts of organic debris and peat. Swamp deposits are clays with minor amounts of organic material having a medium consistency. Marsh and swamp deposits in Unit 4 reach thicknesses of approximately 10 feet. They are underlain by interdistributary deposits which consist of soft to very soft clays with minor amounts of silt reaching a thickness of approximately 90 feet. Prodelta deposits are located beneath interdistributary deposits and consist of medium clays with minor amounts of silts reaching thicknesses of up to 80 feet. Beneath the prodelta are nearshore gulf deposits composed of sand, silt, and shell material reaching thicknesses of 10 feet. Prodelta and nearshore gulf deposits are absent in the northern portion of Unit 4. The Pleistocene surface underlies interdistributary deposits in the northern portion of the Unit and nearshore gulf deposits in the southern portion. The depth to the Pleistocene surface is approximately -50 feet NGVD in the northern portion and gradually increases to -350 feet NGVD at the coast.

Long-term subsidence rates in Unit 4 average approximately 0.58 feet per century. Subsidence rates increase from north to south due to the increasing thickness of Holocene sediments above the stable Pleistocene surface.

Historic Land Loss

The average land loss rate for Unit 4 during the 1932 to 1958 time period was 2.66 sq mi/yr. The rate increased dramatically to 6.35 sq mi/yr during the 1958 to 1974 period and to 8.49 sq mi/yr during the 1974 to 1983 period. The rate decreased slightly to 7.37 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 7). The percentage loss rate increased from 0.15 percent per year during the 1932 to 1958 period to 0.51 percent per year during the 1974 to 1983 period. The percentage loss rate decreased slightly to 0.46 percent per year during the 1983 to 1990 period. By 1990, Unit 4 had lost approximately 16 percent of the land area present in 1932. Direct man-made loss accounted for approximately 17 percent of the total loss from 1932 to 1990. Most of the direct man-made loss occurred prior to 1974. Figure 8 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 4. This figure shows that the northern portion of Unit 4 is generally losing less than 0.1 percent per year. The central portion is losing between 0.1 and 1.0 percent per year and the southern portion from 0.51 to over 1.0 percent per year.

Location of Historic Loss

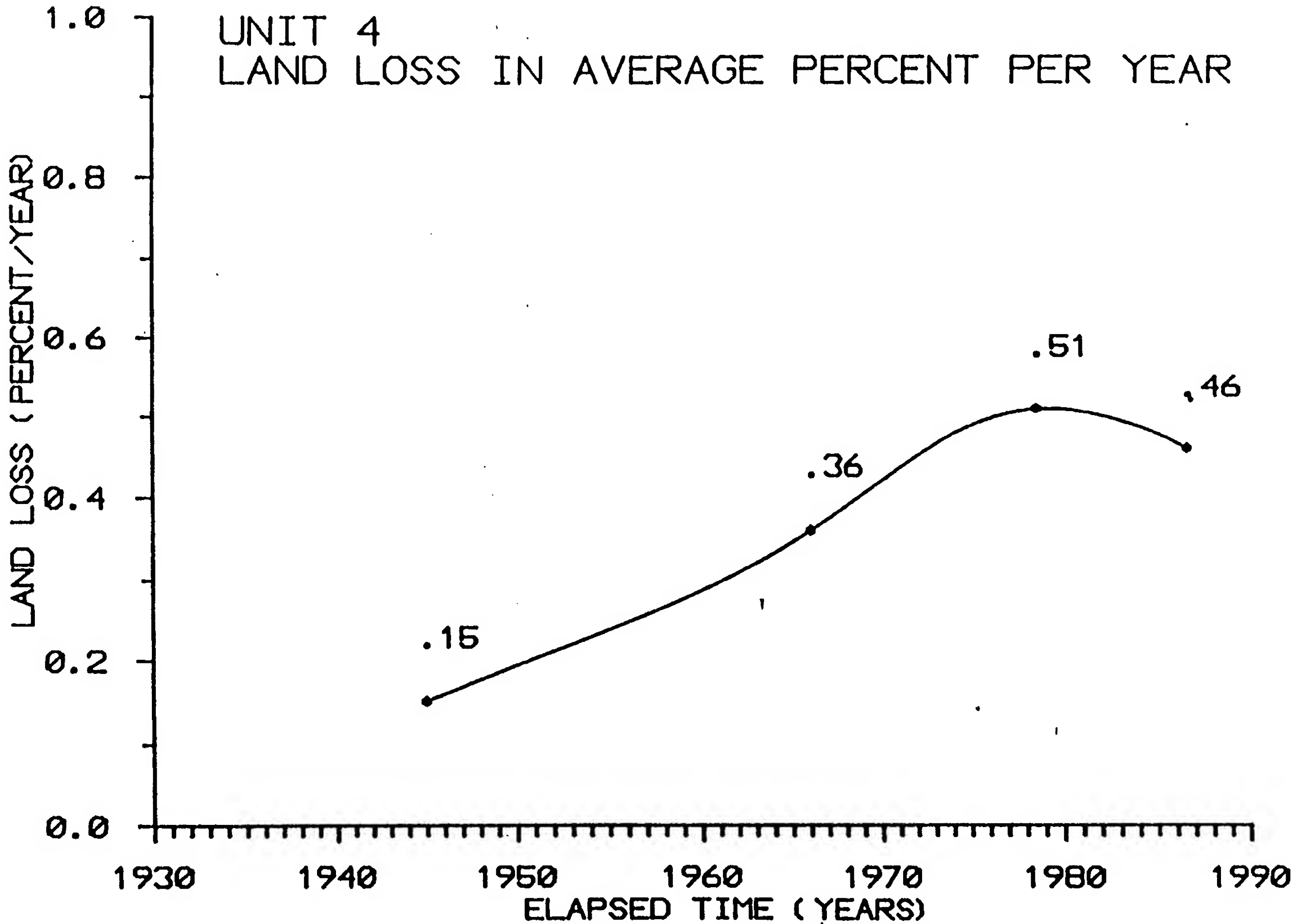

UNIT 4
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
.15
.36
.51
.46
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 7.

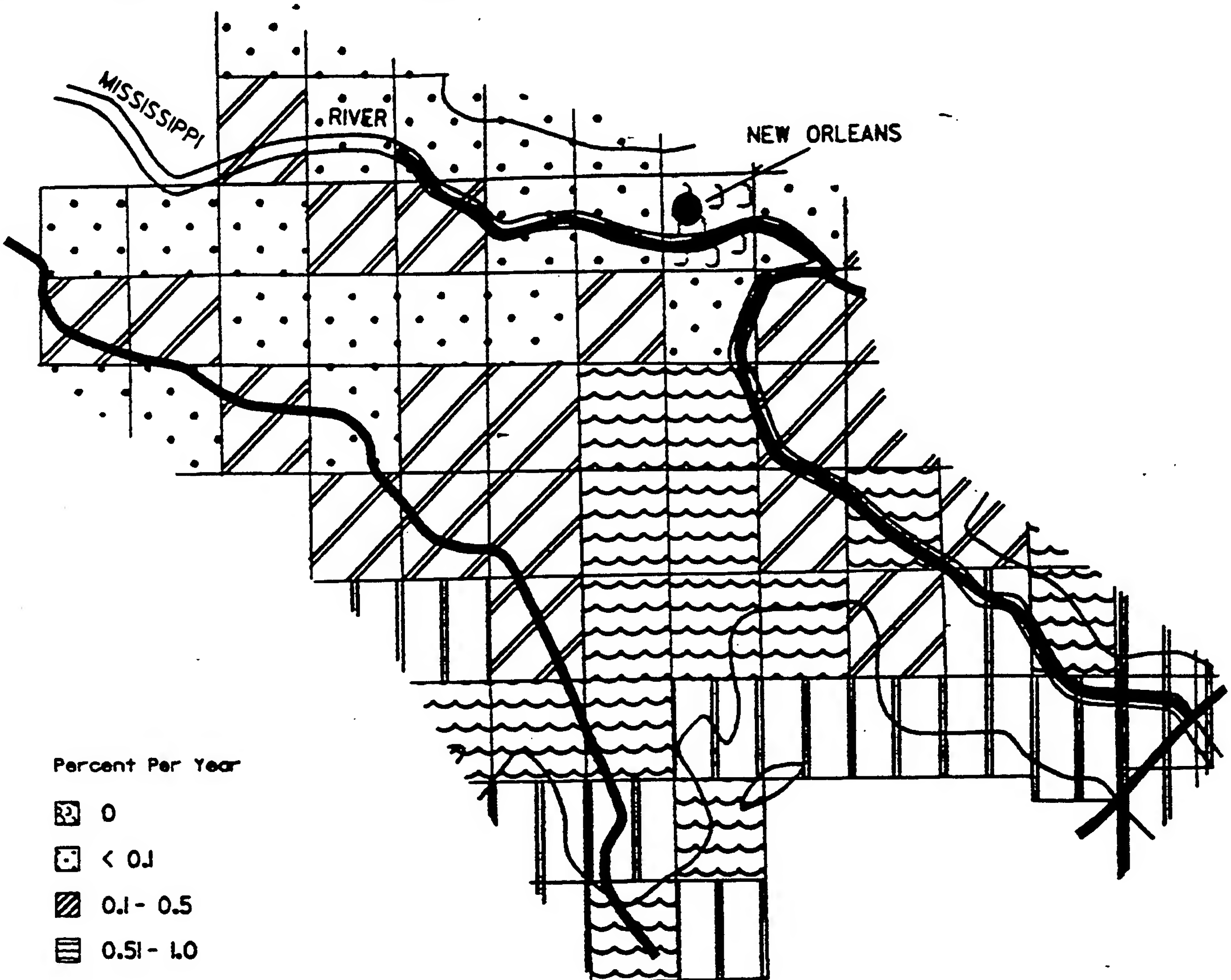


Figure 8. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

Some areas which have experienced high rates of interior marsh loss in Unit 4 include:

1. south of Lake Hermitage near Magnolia, near the Mississippi River
2. due west of Myrtle Grove near the Mississippi River
3. due west and northwest of Lake Cataouatche
4. south of Fort Jackson near the Mississippi River
5. between Bayous Perot and Rigolets near Lafitte
6. adjacent to the Barataria Waterway, south of Lafitte
7. east and west of Bastian and Adams Bay, south of Empire
8. just east of Bayou Lafourche from Leeville to just north of the Gulf shoreline
9. north and south of Bayou L'Ourse, southwest of Little Lake
10. southeast of Lake Grande Ecaille

The loss associated with areas 1, 2, 3, 5, 6, 8, and 9 appears to be related to alterations to the hydrology. In areas 4, 7, and 10, subsidence combined with alterations to the hydrology appear to be the main causes of loss.

Some areas where shoreline erosion rates have been particularly high include:

1. Pointe aux Herbes on Lac Des Allemands
2. the shoreline of Lakes Cataouatche and Salvador
3. the islands and points within and adjacent to Barataria Bay
4. the Gulf shoreline from Barataria Pass eastward to Bay Coquette
5. the shoreline of Catfish Lake east of Bayou Lafourche
6. the shoreline bordering Lakes Felicity and Raccourci
7. the Gulf shore from Belle Pass to just west of Caminada Pass
8. the shorelines adjacent to Bayous Perot and Rigolets
9. the shoreline adjacent to Little Lake

Some sites where direct man-made loss has been particularly high include:

1. near Leeville, west of Bayou Lafourche
2. east and west of Catfish Lake
3. between Lake Bully Camp and Bayou Lafourche
4. east of Lake Grande Ecaille
5. in the marshes adjacent to Adams and Bastian Bays
6. southeast of Lake Hermitage near Magnolia
7. north and west of Bayou Perot
8. east of the Barataria Waterway, south of Bayou Dupont
9. north and south of Delta Farms

The approximate date, location, and morphology of the land

loss provides insight into the major causes of loss. From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the CWPPRA Plan for the Barataria Basin, the primary causes of historic loss in Unit 4 appear to be alterations to the natural hydrology, shoreline erosion, subsidence, and direct man-made loss.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has increased in Unit 4 since 1932, except for a small decrease in the rate during the 1983 to 1990 period. Some areas where land loss rates will probably remain relatively high or increase include all the areas listed above as areas of interior and shoreline erosion under "Location of Historic Loss". In these areas the loss rates have been high for at least 20 years and their is no indication that the rates will not continue to be relatively high.

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. east of Lake des Allemands, east and west of Providence Canal
2. southeast of Crown Point between Bayou La Tour and the Mississippi River
3. between the Harvey Cutoff and the Barataria Bay Waterway
4. east and west of Grand Bayou just south of the Freeport Sulphur Co. Canal

At these sites, alterations to the natural hydrology may lead to an increase in the land loss rate.

5. Sites where the eroding lake shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from the lakes to act directly on previously protected interior marshes. This has, or will likely occur at the following locations:
    a. along the northwest shoreline of Lake Salvador
    b. Brusle Lake and Coffee Bay adjacent to Little Lake
    c. between Little Lake and the Barataria Bay Waterway
    d. north and south of Bay l'Ours near the southern end of Bayou l'Ours
    e. Bay Batiste and the bays to its northwest
    f. between Bayous Rigolettes and Perot

The direct man-made loss due to dredging activity in Unit 4 has decreased since 1974 and will probably continue to decrease.

Permits

Fourteen marsh management permits have been issued within Unit 4 (Fig. 4-4). Waterfowl management and marsh restoration

are the primary purposes stated for these projects. A lack of detailed information on each permitted area precludes a specific discussion of these areas. Therefore areas with similiar settings have been grouped and some general observations are provided.

The areas included in permit #'s 226, 480, 529, 110, 192, 718, and 229 have experienced high rates of interior marsh loss within the past 60 years. The areas covered by permit #'s 547, 517, and 577 have experienced high rates of man-made loss as well as interior loss. The loss that has occurred in all of these areas appears to be related to alterations to the natural hydrology. The interactions between man-made and natural geomorphic features has led to increased hydoperiods, tidal scour, and saltwater intrusion.

Areas included in permit #'s 540 and 215 have experienced high rates of man-made loss, but relatively little interior loss. Shoreline erosion has also been high at number 215. Although past interior loss in these areas has been relatively low, alterations to the natural hydrology already in place may lead to increased future loss if the proposed projects fail to address these alterations.

The areas covered by permits 107 and 733 have had little loss in the past 60 years. Alterations to the natural hydrology do exist at these sites which should be considered in any management plan.

CWPPRA

The restoration plan developed under the CWPPRA for the Barataria Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Barataria Basin follows the same boundaries as Chabrecks' Unit 4. As summarized from CWPPRA, the primary causes of wetland loss in the Barataria Basin is attributed to a combination of natural and man-made causes, primarily due to a lack of sediments, relative subsidence, erosion, herbivory, channelization, levee construction, and development.

Specific planning objectives include restoring fluvial inputs, maintaining and restoring central basin marshes ,barrier islands, and fringe marshes, and reducing tidal exchange between the upper and lower basin. Figure 4-5 shows the locations of the proposed marsh management projects in Unit 4 from the CWPPRA Plan. Four of these projects have been partially or wholly permitted and are discussed somewhat under "Permits". All of the project areas proposed by CWPPRA have experienced high rates of land loss in the past 60 years. However, projects BA-6 and XBA-49 have experienced mainly direct man-made loss and minor interior loss rather than the high rates of interior loss common in the other project areas. Historic land loss and geomorphic data suggests that much of the interior marsh loss is related to

alterations to the natural hydrology, especially as it relates to increased tidal scour. The project strategies include creating barriers to reduce tidal exchange and increasing fresh water retention. These strategies should benefit these areas assuming that excessive water levels do not result.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that 76,160 acres (16.6%) of the Basin's existing wetlands would be lost to open water over the next 20 years without implementation of proposed projects.

Summary

In summary, both the square miles and percentage of land being lost annually in Unit 4 has continued at a high rate over the past 60 years. A large percentage of this loss has occurred in the middle and lower portions of the Unit. Shoreline erosion, alterations to the natural hydrology, relative subsidence, and direct man-made loss appear to be the major causes of loss in this Unit. The rate of loss will probably remain the same or decrease slightly over the next 20 years under existing conditions assuming a continued decrease in man-made loss and a small decrease in interior marsh loss.

Unit 5

Location

Unit 5 has the largest marsh area and extends from Bayou Lafourche to the east levee of the Atchafalaya River (Fig.1).

Geologic Setting

Unit 5 is located in the south-central portion of the Deltaic Plain. This Unit is characterized by a complex network of abandoned distributaries and their associated natural levees separated by swamp and marsh deposits. Inland swamp is common in the northern portion of the Unit bordering Bayous Black and Lafourche and paralleling some of the larger abandoned distributary channels such as Bayous Dularge, Grand Caillou, and Terrebonne. Fresh and intermediate marsh is common in the northern half of the Unit. Much of this marsh is of the floating variety. Brackish and saline marshes make up the southern half

of the Unit with a large zone of saline marsh paralleling the coast.

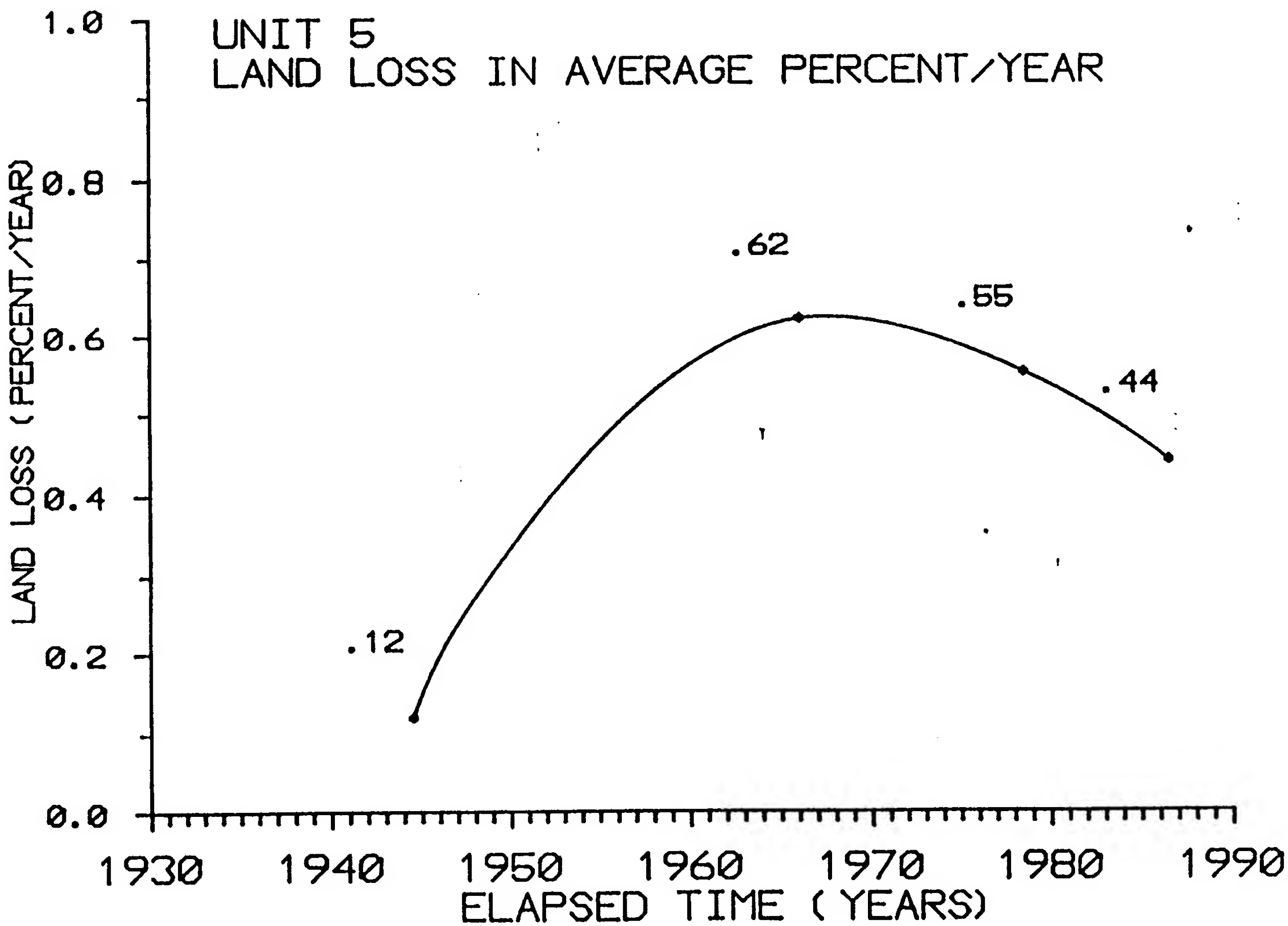
Dominant physiographic features includes Bayous Black, Lafourche, DuLarge, Grand Caillou, Petit Caillou, Terrebonne, and Blue and their associated natural levees. Also, the Gulf Intracoastal Waterway, Houma Navigation Channel, Isles Derniere and Timbalier Island, and numerous inland lakes such as Decade, Mechant, and Boudreaux. Elevations in Unit 5 range from +10 feet NGVD on the natural levees bordering Bayous Black and Lafourche to near 0 feet NGVD in the marshes.

Typical geologic profiles in the area show a thick sequence of Holocene deltaic sediments underlain by Pleistocene deposits. Holocene sediments are composed of natural levee, swamp, and marsh deposits up to 40 feet thick adjacent to the major distributaries. These deposits are underlain by up to 180 feet of interdistributary deposits composed of soft to very soft clays with some silt lenses and shell material. Below the interdistributary deposits are substratum sands composed of silty sands with minor amounts of gravel. Substratum sands up to 200 feet thick are found in Unit 5. These sands are related to the Mississippi River Entrenchment which runs through Unit 5. Beneath the substratum sands is the Pleistocene surface. The Pleistocene is generally composed of oxidized stiff clay with minor amounts of silt and sand. In Unit 5 the Pleistocene surface elevation ranges from -120 feet NGVD to -400 NGVD feet. The Pleistocene surface varies with the depth of the Mississippi River Entrenchment.

The thick sequence of unconsolidated Holocene sediments in Unit 5 is responsible for the relatively high subsidence rates in this area of the Louisiana coast. The average subsidence rate for Unit 5 is 0.66 feet per century. Subsidence rates greater than 1.0 foot per century are common at many locations in Unit 5.

Historic Land Loss

The average yearly land loss rate for Unit 5 was 1.93 sq mi/yr for the 1932 to 1956 period. The rate increased dramatically to 9.65 sq mi/yr during the 1956 to 1974 time period. The rate then decreased to an average of 7.74 sq mi/yr during the 1974 to 1983 period and continued to decrease to 5.78 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 9). The average percentage loss rate peaked at 0.62 percent per year during the 1956 to 1974 period. It began to decrease after that period and was 0.44 percent per year during the 1983 to 1990 time period. By 1990, Unit 5 had lost approximately 20 percent of the land area present in 1932. Direct man-made loss accounted for approximately 13 percent of the total loss from 1932 to 1990. Most of the direct man-made loss occurred prior to 1974. Figure 10 shows the average annual percentage of land being lost for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles


UNIT 5
LAND LOSS IN AVERAGE PERCENT/YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
.12
.62
.55
.44
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

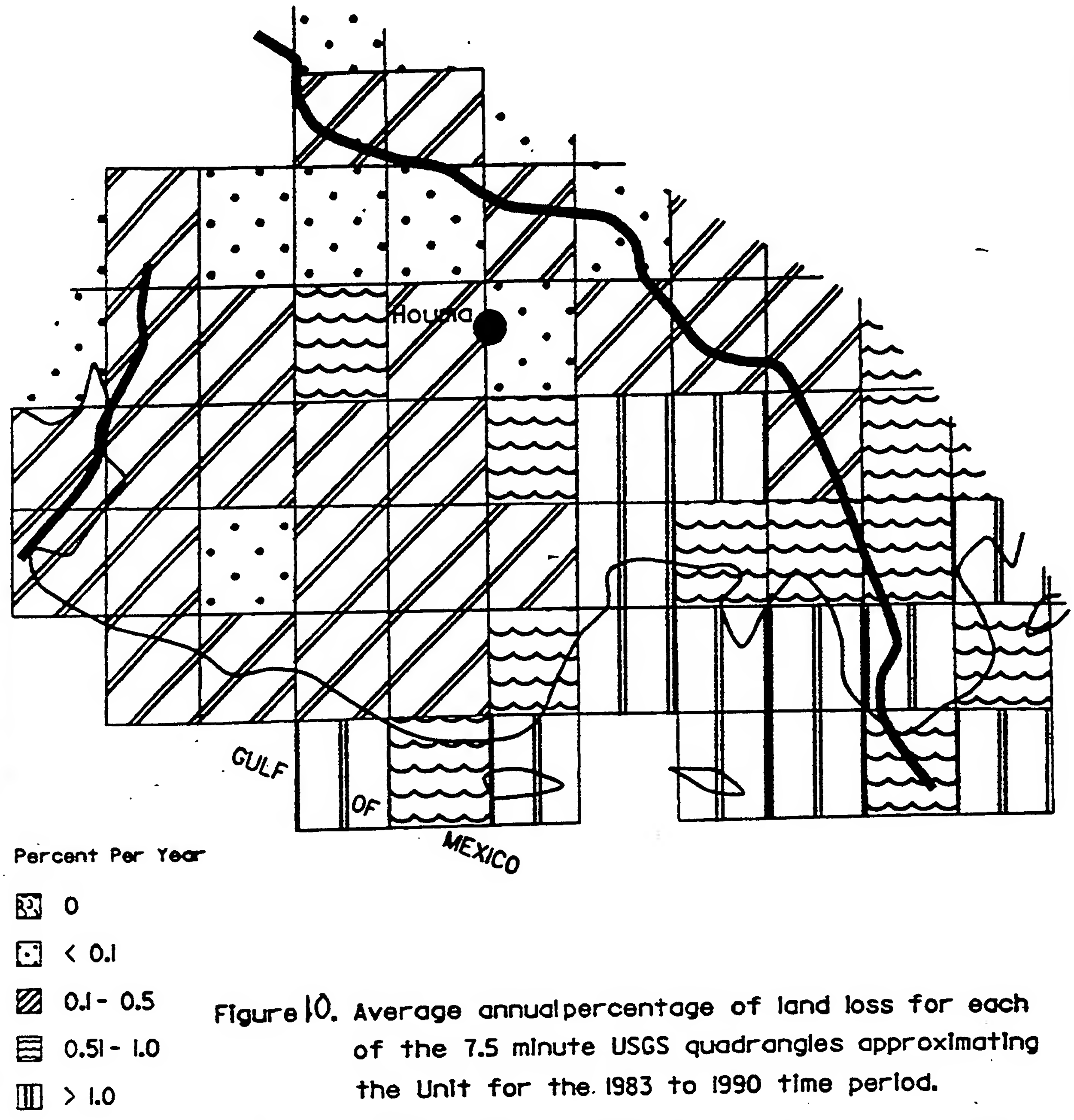


Figure 10. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

approximating Unit 5. This figure shows that the northern, western, and southwestern portions of Unit 5 are generally losing less than 0.5 percent per year while the eastern and south-eastern portions are generally losing 0.51 to over 1.0 percent per year.

Location of Historic Loss

Some areas which have experienced high rates of interior marsh loss in Unit 5 include:

1. Avoca Island
2. between Turtle Bayou and Bayou Copasaw, north of Bayou Penchant
3. east of Bayou Copasaw, south of the Intracoastal Waterway
4. between Lake Cocodrie and Hanson Canal, north of the Intracoastal Waterway
5. east and west of Carencro Bayou
6. the central portion of Point Au Fer Island
7. between Lost Lake and Lake Decade
8. north and south of Falgout Canal between Lake Decade and the Houma Navigation Canal
9. north of Lake Boudreaux, east and west of Bayou Chauvin
10. between Bayou's Terrebonne and Petit Caillou, along Bayou la Cache
11. adjacent to Madison Bay
12. adjacent to Wonder Lake
13. between Bayou Pt au Chien and Bayou Lafouche in the vicinity of Lake Bully Camp
14. east and south of Catfish lake

The loss in all of these areas, except 1, appears to be related to alterations in the hydrology, especially those which increase tidal scour. Area 1 is the site of a failed reclamation in which drainage-induced subsidence has led to land loss.

Some areas where shoreline erosion rates have been especially high include:

1. South Point, adjacent to Fourleague Bay
2. Pt au Fer
3. southwest shore of Lost Lake
4. east shore of Lake Decade
5. Isles Dernieres and Timbalier and East Timbalier Islands
6. Lake Boudreaux shoreline
7. along the marshes and islands bordering Lakes Barre, Felicity, and Raccourci and Pelto, Timbalier, and Terrebonne Bays
8. the banks of the Houma Navigation Canal and the Intracoastal Waterway
9. the banks bordering Avoca Cutoff, Bayou Chene, and Bayou Penchant

Some sites where direct man-made loss has been relatively high include:

1. east and west of Catfish Lake

2. the vicinity of Wonder Lake
3. north of Lake Bully Camp
4. the vicinity of Hackberry Lake, adjacent to Bayou Grand Caillou
5. the Houma Navigation Canal
6. the vicinity of Turtle Bayou
7. north and south of the Intracoastal Waterway from Hanson Canal to Lake Cocodrie
8. between Bayou Penchant and Carencro Lake

From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the CWPPRA Plan for the Terrebonne Basin, the primary causes of historic land loss in Unit 5 appear to be alterations to the natural hydrology, shoreline erosion, and direct man-made loss.

Future Areas of Loss

As shown previosly, both the square miles and percentage of land being lost in Unit 5 has decreased substantially since the 1958 to 1974 period. However, even with this decrease, Unit 5 is losing land at a rate of almost 6 sq mi/yr. The main reason for this decrease was the reduction in interior marsh loss since 974; especially in the Penchant subbasin.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. all of the areas of historic shoreline erosion listed previously
2. Avoca Island
3. northeast of Lake Cocodrie
4. between Lost Lake and Lake Decade
5. south of Falgout Canal between Bayou du Large and the Houma Navigation Canal
6. in the vicinity of Madison Bay
7. between Wonder Lake and Bayou Lafourche
8. east and south of Catfish Lake
9. north of Lake Boudreaux, east and west of Bayou Chauvin

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. Areas where the eroding shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from large water bodies to act directly on previously protected interior marshes. This is occurring throughout the southern half of Unit 5.
2. Areas where alterations to the hydrology exist that may cause loss rates to increase. Sites where this may occur include:
    a. south of Bayou Blue, west of Grand Bayou Canal

b. between Little Lake and Bayou Lafourche

c. south of Lake Decade between Bayou la Pointe and Bayou du Large

The direct man-made loss due to dredging activity in Unit 5 has decreased since the 1958 to 1974 period and will probably continue to decrease.

Permits

Thirteen marsh management permits have been issued within Unit 5 (Fig. 5-4). Waterfowl management and marsh restoration are the primary purposes stated for these projects. Permit #'s 870, 628, 625, 83, 696, and 943 have experienced high rates of interior and man-made land loss. Permit #'s 991, 478, the southern half of 2, and 146 are characterized by high rates of interior land loss. Alterations to the hydrology appear to be responsible for much of the loss in these areas except for #146 where drainage-induced subsidence is the main cause of past loss. In Unit 5, alterations to the hydrology result in an increase in the duration of flooding, tidal scour, and salt water intrusion as well as other processes that may lead to land loss. Therefore, any projects proposed in these areas should consider the role that alterations to hydrology have played in the loss rates. Permit #'s 703 and 169 have experienced relatively little past loss. However, alterations to the hydrology do exist at #169. Permit #953 has experienced high rates of shoreline erosion. Nine of the 13 previously permitted projects are wholly or partially contained on the CWPPRA list of proposed projects.

CWPPRA

The restoration plan developed under the CWPPRA for the Terrebonne Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. As summarized from CWPPRA, the primary causes of wetland loss in the Terrebonne Basin are hydrologic alterations, salt water intrusion, subsidence, and loss of barrier islands. The key planning objectives were: 1) restoration of fluvial inputs of sediment and water; 2) presevation of existing marsh in the Timbalier, Penchant, and Fields Subbasins; and 3) restoration of hydrologic conditions conducive to cypress regeneration in the Verret Subbasin.

Figure ? shows the location of the proposed marsh management projects in Terrebonne Basin from the CWPPRA Plan. All of the projects proposed by CWPPRA are characterized by relatively high rates of interior marsh loss except for #'s XTE 47/48 and PTE 22/24 which have experienced only moderate loss. Also, #XTE-28, the parish line of defence, a regional project which does include some areas of interior loss, generally covers the upper, central portion of the Basin where overall loss rates are relatively low. Most of the proposed projects are confined to an east-west band

of fresh (much of it floating), intermediate, and brackish marshes in the central and northern parts of the Basin. These marshes appear to be extremely sensitive to changes in the hydrology; especially those that increase the duration of flooding, allow salt water intrusion, and increase tidal scour. This is evidenced by the fact that prior to 1956, when man-made alterations to the hydrology were relatively minimal, the loss rate in Terrebonne Basin was 2.32 sq mi/yr. By 1974, when mans activities were near a maximum, the loss rate accelerated to 9.34 sq mi/yr. Alterations to the natural hydrology of this Basin are responsible for a large percentage of the interior marsh loss which has occurred. Shoreline erosion and direct man-made loss are also big contributors to land loss in this Basin.

The general concepts of the projects proposed for this Basin are better use of sediments and fresh water and reduction of tidal exchange and salt water intrusion. The projects proposed by CWPPRA should benefit the Basin as long as the ability to remove excess water within project boundaries is possible.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that approximately 87,800 acres (14.4%) of loss will occur over the next 20 years if no restoration action is taken. Most of the loss will be concentrated in the Timbalier Subbasin.

Summary

In summary, both the square miles and percentage of land being lost annually in Unit 5 continues at a high rate and will probably remain high over the next 20 years. As shown in Figure 10, during the 1983 to 1990 period the southeastern portion of the Unit generally lost 0.5 to over 1.0 percent of its land area each year. The remaining portion of the Unit generally lost 0.5 percent or less of its land area. Shoreline erosion and alterations to the hydrology will probably continue to be the major causes of loss in Unit 5.

UNIT 6

Location

Unit 6 is the smallest hydrologic unit and includes primarily the marsh area between the Atchafalaya River and Wax Lake Outlet (Fig. 1).

Geologic Setting

Unit 6 is located in the southwestern portion of the Mississippi River Deltaic Plain. This Unit is comprised of inland swamp in the northern half of the Unit and fresh marsh in the southern half. Dominant physiographic features include Bayou Teche and its associated natural levees, abandoned distributaries of the Teche Delta, the Atchafalaya River, and Belle Isle Dome. Elevations generally range from +10 feet NGVD on the natural levees bordering Bayou Teche to near 0 feet NGVD in the southernmost marshes. Elevations reach +75 feet NGVD on the Belle Isle Dome.

Typical geologic profiles in the area show characteristic depositional environments of the Deltaic Plain. The upper Holocene sediments are generally less than 50 feet thick except in the extreme northern and eastern portion of the Unit where the western side of the Mississippi River entrenchment begins. Holocene sediments in this portion of the entrenchment reach 200 feet in thickness. Outside the entrenchment the Holocene sediments are generally composed of up to 20 feet of marsh and swamp deposits overlying approximately 30 feet of interdistributary deposits. Natural levee deposits up to 30 feet thick border Bayou Teche. Marsh deposits are composed of highly organic clay and peat. Swamp deposits are generally soft to medium clay with minor amounts of silt and organics. Interdistributary deposits are composed of very soft clays with minor amounts of silt. Natural levee deposits are medium to firm clays and silts having lower water contents and higher compressive strengths than the surrounding environments. The Holocene deposits are underlain by the Pleistocene at a depth of approximately -60 feet NGVD.

In the Mississippi River entrenchment; marsh, swamp, and interdistributary deposits are underlain by sands and gravels down to the Pleistocene surface at approximately -200 feet NGVD. The thick sequence of marsh and swamp deposits in Unit 6 is indicative of the stability of this area relative to deltaic progradation. Prior to the recent influx of sediment from the Atchafalaya River, this Unit had received no major influx of riverine sediments since the Teche Delta was active in this area approximately 4000 years before present. This allowed marsh and swamp deposits to develop virtually uninterrupted during this period.

The close proximity of the Pleistocene surface in most of this Unit, coupled with accretion resulting from Atchafalaya River sedimentation, is responsible for the relatively low subsidence rate in this Unit. Long-term relative subsidence rates in Unit 6 average approximately 0.34 feet per century. Relative subsidence rates in the extreme northern and western portion of the Unit are over 0.50 feet per century due to the thick sequence of unconsolidated sediments in the Mississippi River entrenchment. However, active sedimentation from the Atchafalaya River has been able to balance these relatively

higher subsidence rates.

Historic Land Loss

The average land loss rate for Unit 6 was 0.21 sq mi/yr during the 1931 to 1956 period. The rate increased to 0.28 sq mi/yr for the 1956 to 1974 period, then decreased to 0.15 during 1974 to 1983 and 0.12 during the 1983 to 1990 period. The higher loss rate in the first two time periods is largely the result of direct man-made loss which accounted for approximately 39 percent of the total during these two periods. The natural land loss rate has been relatively stable throughout all four time periods, showing only a slight decrease since 1974. The average annual percentage of land being lost has followed the same trend (Fig. 11). It peaked at 0.20 percent per year during the 1956 to 1974 period and decreased to 0.09 percent per year during the 1983 to 1990 period. By 1990, Unit 6 had lost approximately 9 percent of the land area present in 1932.

Two main factors are responsible for the relatively low land loss rate in Unit 6:

1. Sediment and fresh water input from the Atchafalaya River.
2. The relatively shallow depth of the Pleistocene surface resulting in relatively lower subsidence rates.

Figure 12 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles approximating Unit 6. This figure shows that rates are less than 0.1 percent per year for most of Unit 6.

Land accretion is occurring mainly in Atchafalaya Bay at the mouths of the Atchafalaya River and Wax Lake Outlet and along Wax Lake Outlet and the Atchafalaya River.

Location of Historic Loss

Some areas which have experienced high rates of shoreline erosion in Unit 6 include:

1. the Bay shoreline from Wax Lake Outlet to the Atchafalaya River
2. along the Gulf Intracoastal Waterway
3. along the Lower Atchafalaya River, south of Sweet Bay Lake

Sites where direct man-made loss has been relatively high include:

1. the marshes in the vicinity of Belle Isle
2. west of the Atchafalaya River,east of Big Willow Bayou
3. on Bateman Island

Interior marsh loss has been relatively low in Unit 6. The primary causes of land loss in Unit 6 appear to be shoreline erosion and direct man-made loss from dredging.

Future Loss Trends

Areas where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline from Wax Lake Outlet to the Atchafalaya River
2. The interior marshes between Big Willow Bayou and the Atchafalaya River, and the interior marshes of Bateman Island. In these areas man-made alterations to the hydrology may lead to an increase in the interior marsh loss occurring in these areas.
3. the shoreline of Lower Atchafalaya River south of Sweet Bay Lake

An area where land loss rates have been relatively low but may increase in the future is found in the vicinity of Belle Isle. In this area, a dense network of canals has led to alterations in the surface hydrology making the area susceptible to interior marsh loss.

The direct loss due to dredging activity in Unit 6 has decreased since 1974 and will probably continue to decrease.

Permits

There are no marsh management permits in Unit 6 at this time.

CWPPRA

There are no marsh management projects proposed in the CWPPRA Plan for the Atchafalaya Basin. The Atchafalaya Basin closely approximates Unit 6 except for the the area between Wax Lake Outlet and Bayou Sale which is not contained in Unit 6.

Summary

Direct man-made loss has accounted for approximately 35 percent of the total loss in Unit 6 since 1931. If man-made loss was excluded, the land loss rate would have remained relatively stable during the 1931 to 1990 period.

As shown in Figure 12, the majority of Unit 6 lost less than 0.1 percent of its land area each year during the 1983 to 1990 period.

The overall rate of loss in Unit 6 should continue to decrease slowly assuming the continued decline in direct man-made loss, and continued sediment influx from the Atchafalaya River.

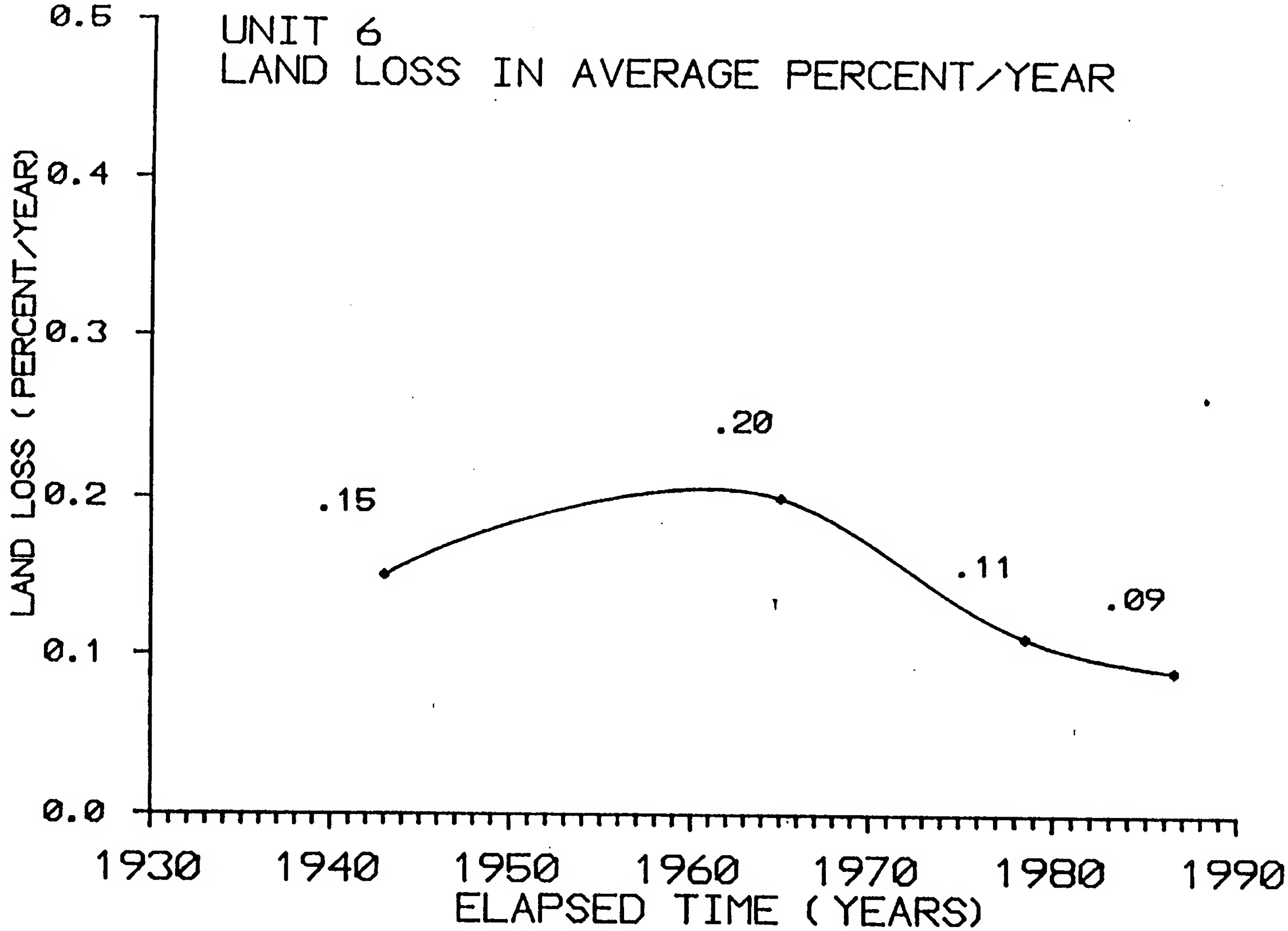

UNIT 6
LAND LOSS IN AVERAGE PERCENT/YEAR
LAND LOSS (PERCENT/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
.15
.20
.11
.09
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 11.

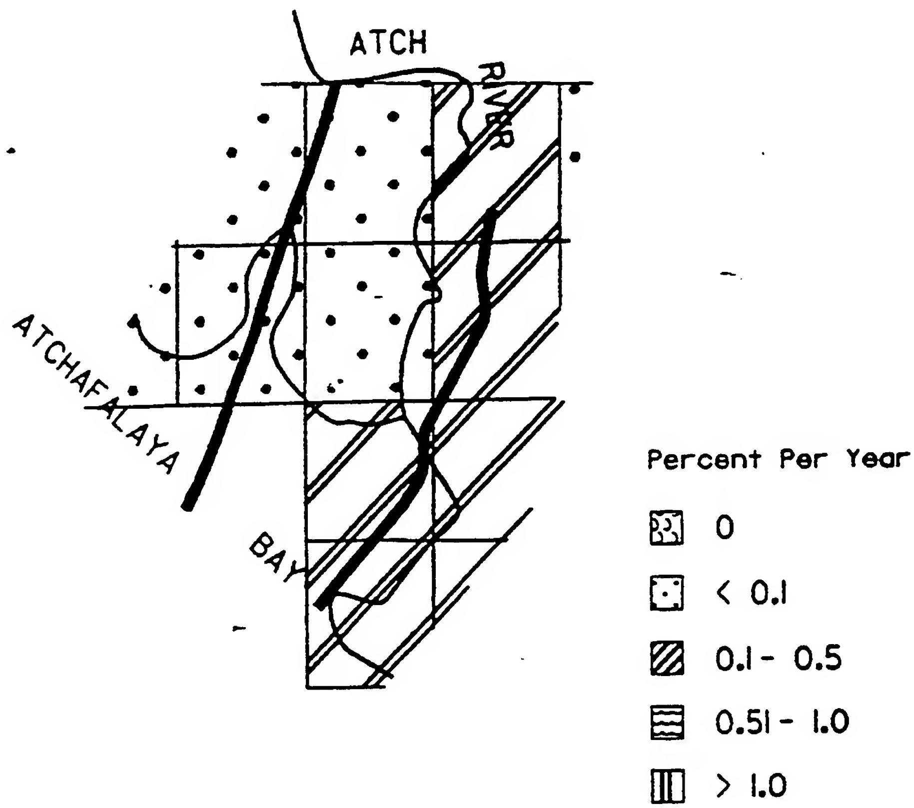


Figure 12. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

Unit 7

Location

Unit 7 includes Marsh Island, Vermilion Bay, East and West Cote Blanche Bays, and the marshes that surround these bays. The eastern boundary is Wax Lake Outlet. The western boundary lies along a line beginning at the Gulf of Mexico in Vermilion Parish about 5 miles west of the mouth of Freshwater Bayou Gulf Outlet. From this point the line trends northeast to the Schooner Bayou Control Structure and the Vermilion Locks, then north to the northern boundary of the coastal marsh (Fig. 1).

Geologic Setting

Unit 7 is located partially in the extreme eastern portion of the Chenier Plain and partially in the extreme western portion of the Deltaic Plain. This unit is comprised predominantly of brackish marshes in the western half and fresh marshes in the eastern half. The influence of the Atchafalaya River to the east of Unit 7 is responsible for the large expanse of fresh marsh in the eastern half of Unit 7. Inland swamp is common between the Pleistocene outcrops on the north and the coastal marshes.

Dominant physiographic features include Marsh Island, Vermilion, West Cote Blanche, and East Cote Blanche Bays, Jefferson Island, Avery Island, Weeks Island, and Cote Blanche Island salt domes, and Bayous Cypremort and Sale, which are abandoned distributaries of the Teche Delta. Elevations are generally at marsh level except for the natural levees bordering Bayous Teche, Cypremont, and Sale, the Pleistocene outcrops, and the salt domes common in the area. Elevations up to +15 feet NGVD are found adjacent to Bayou Teche and on the Pleistocene surface, and may exceed +100 feet NGVD at the salt domes.

Typical geologic profiles in the area show the characteristic depositional environments of the deltaic plain. The upper Holocene sediments are generally less than 50 feet thick. The Holocene is composed of numerous abandoned distributaries and their associated natural levees separated by marsh and swamp deposits. The natural levees are composed of oxidized clay and silty clay with minor amounts of silt. Natural levees generally have higher compressive strengths and lower water contents than the surrounding environments making them less susceptible to erosion. Swamp deposits are composed of soft to medium clay with some organics. Marsh deposits are composed of organic clays with high amounts of organic debris and peat. Swamp and marsh deposits in Unit 7 are up to 20 feet thick. They are underlain by interdistributary deposits composed of soft to very soft clays with minor amounts of silt, and have high water

content. The interdistributary sediments continue down to the Pleistocene surface which is approximately -50 feet NGVD at Marsh Island and decreases inland where it outcrops south of Bayou Teche.

The thick continuous sequence of marsh and swamp deposits is indicative of the fact that Unit 7 has received no major influx of riverine sediments since the Teche Delta was active in this area approximately 4000 years before present. The close proximity of the Pleistocene surface is responsible for the relatively low subsidence rates in this Unit which have allowed the accretion of marsh and swamp deposits to generally keep pace with subsidence. Long-term subsidence rates in Unit 7 are approximately 0.43 feet/century.

Also, since the 1950's an increasing amount of sediment has reached Unit 7 from the Lower Atchafalaya River and Wax Lake Outlet which has helped this area maintain marsh elevation.

Historic Land Loss

The land loss rate for Unit 7 has remained relatively stable since 1932. The average rate was 0.84 sq mi/yr during the 1932 to 1951 period. It peaked at 2.03 sq mi/yr during the 1951 to 1974 period, then decreased to 1.27 sq mi/yr for the 1974 period to 1983 period. The rate increased slightly to 1.51 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same pattern. It peaked at 0.24 percent during the 1951 to 1974 period and decreased to 0.19 percent per year for the 1983 to 1990 period (Fig. 13). By 1990, Unit 7 had lost approximately 9 percent of the land area present in 1932. Since 1932, the land loss rate for Unit 7 since 1932 has been relatively low when compared to most of the other hydrologic units in coastal Louisiana. Several factors contribute to this reduced rate of loss:

1. Sediment and fresh water input from the Atchafalaya River located east of Unit 7.
2. The shallow depth of the Pleistocene surface (<50 feet) which accounts for a lower relative subsidence rate as compared to other areas in the deltaic plain.
3. The reduced amount of direct man-made loss relative to other areas along the coast.
4. The high percentage of natural levee and swamp deposits in this Unit related to abandoned distributaries of the Teche Delta which are more resistant to erosion than marsh deposits.

As shown in Figure 13, the highest loss rate occurred during the 1951 to 1974 period which is common for most of coastal Louisiana. Direct man-made loss accounted for approximately 20 percent of the total loss from 1932 to 1990. Figure 14 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 7. This figure shows that rates

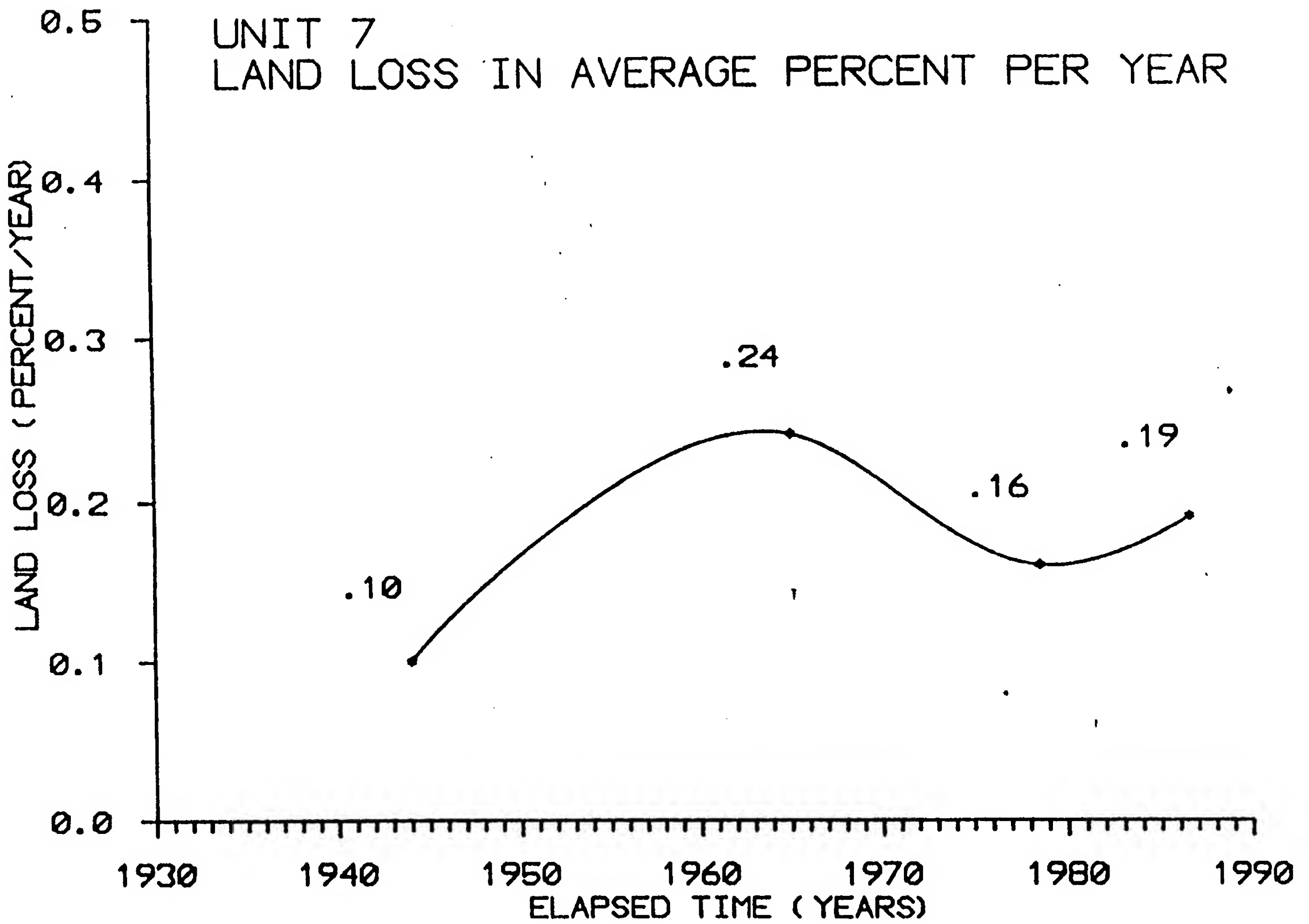

UNIT 7
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS (PERCENT/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
.10
.24
.16
.19
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 13.

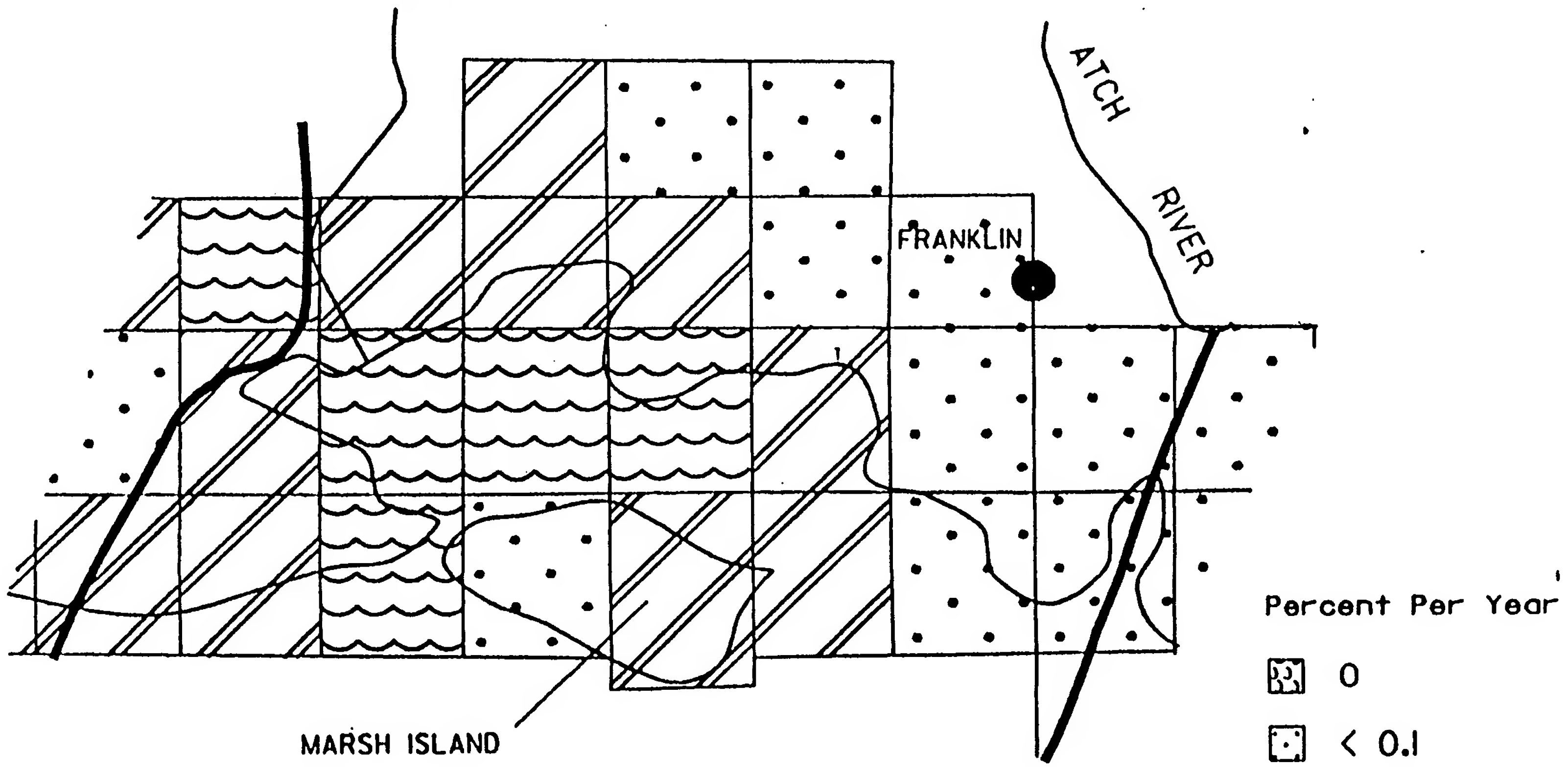


Figure 14. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

.re generally less than 0.5 percent per year except for 4 quadrangles bordering Vermilion Bay and the Gulf where rates are between 0.5 and 1.0 percent per year.

Locations of Historic Loss

Some areas which have experienced high rates of interior marsh loss in Unit 7 include:

1. east of Intracoastal City on the north and south side of the Gulf Intracoastal Waterway (GIWW)
2. northeast of Marone Point,
3. in the central portion of Marsh Island
4. east of McIlhenny Canal in the Paul J. Rainey Wildlife Sanctuary

Some areas where shoreline erosion rates have been especially high include:

1. along the GIWW, Schooner Bayou and Vermilion River Cutoffs
2. at the mouth and east of Freshwater Bayou Canal
3. the north and southeast shore of Marsh Island
4. Lake, Marone, Blue, Pelican, and Lighthouse Points and Point Chevreuil
5. the shoreline from Dead Cypress Point to Cote Blanche Island
6. south of Bayou Petite Anse on the north shore of ermilion Bay

Some sites where direct man-made loss has been relatively high include:

1. the marshes surrounding Weeks Island
2. adjacent to the east side of Bayou Sale from Ellerslie to the Gulf
3. north of the Intracoastal Waterway between Mud Lake and Bayou Sale
4. between the Intracoastal Waterway and Marone Point, west of Bayou Sale

From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of historic land loss in Unit 7 appear to be shoreline erosion, direct man-made loss, and alterations to the natural hydrology.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has remained relatively stable between 1932 and 1990. The main reason for this stability is the fact that shoreline erosion accounts for a large percentage of the total

loss in Unit 7. Because shoreline erosion is predominantly a natural process, the rates tend to be relatively constant over time.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. all of the shoreline areas identified previously under "Location of Historic Loss"

2. east of Intracoastal City, north and south of the Intracoastal Waterway

3. east of McIlhenny Canal in the Paul J. Rainey Wildlife Sanctuary

In the areas identified in 2 and 3, alterations to the hydrology appear to be related to marsh loss.

Some areas where land loss rates have been relatively low but may increase include sites where the eroding bay shorelines intersect isolated lakes or ponds in the interior marshes. This allows waves and currents from the bays to act directly on previously protected interior marshes. This has or may occur at Lake Cock, located approximately 7 miles east of Vermilion River Cutoff; North Lake, located near the western shore of Vermilion Bay; Hammock Lake near Dead Cypress Point; and Lake Tom and Lake Sand in the northeast portion of Marsh Island.

Land loss rates may also increase at sites where man's activities have led to alterations in the surface hydrology making them susceptable to marsh loss. This may occur north of the Intracoastal Waterway between Mud Lake and Bayou Sale and east of Bayou Sale in the vicinity of Horseshoe Bayou.

The direct man-made loss due to dredging activity has decreased since 1974 and will probably continue to decrease.

Permits

Ten marsh management permits have been issued within Unit 7 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects. All of the permitted areas except for #'s 1 and 84 have experienced relatively high rates of land loss over the past 60 years. Man-made loss is also common in most of the permitted areas. Land loss appears to be continuing in these areas. Man-made alterations to the hydrology (usually in the form of access canals and their associated levees) in conjunction with natural geomorphic features appear to be responsible for much of the loss in the permitted areas. Therefore, any projects designed for marsh management should consider the ability of the project features to control relative water levels and minimize prolonged flooding.

The area included in #'s 1 and 84 have experienced relatively little historic loss and their is no indication that rates will increase significantly in the near future.

Permit #153 is partially contained in a project proposed by CWPPRA.

CWPPRA

The restoration plan developed under the CWPPRA for the Teche/Vermilion Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Teche/Vermilion Basin closely approximates Hydrologic Unit 7 as defined by Chabreck, 1972. As summarized from CWPPRA, the primary causes of wetland loss in the Teche/Vermilion Basin are shoreline erosion and hydrologic changes that alter the balance between the marsh maintenance and deterioration processes. The key planning objectives for the Basin include:1)maximize the flooding of marshes with flowing, fresh, sediment-rich water; 2)slow, stop, or reverse marsh loss in hot spots; and 3)protect critical shorelines.

Figure ? shows the location of the proposed marsh management projects in Unit 7 from the CWPPRA Plan. A portion of TV-4 has been permitted. The areas covered by proposed projects TV-10, TV-1, TV-8, and TV-5/7(1) have experienced high rates of shoreline erosion during the past 60 years. Project #'s TV-10 and TV-5/7(1) also contain some man-made loss. All four of these project areas have experienced minimal interior loss. Any projects designed to retard shoreline erosion should benefit these areas, especially if the protection is able to keep the shoreline from intersecting interior lakes and ponds. The area covered by project TV-4 is characterized by high interior, shoreline, and man-made loss. Alterations to the hydrology, especially those which have increased tidal scour and impoundment, appear to be responsible for much of the interior loss in this area. The proposed project should be beneficial assuming that ponding of water in the interior marshes is avoided.

In addition to those projects classified as marsh management, CWPPRA has proposed other projects which address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that 14,700 acres (6.1%) of loss will occur in the next 20 years without project implementation. Much of this loss will be in the form of shoreline erosion and conversion of interior marshes to shallow ponds.

Summary

As discussed previously, during the 1983 to 1990 period a majority of Unit 7 was losing less than 0.5 percent of its land area each year. Only 4 quadrangles bordering Vermilion and West Cote Blanche Bays were losing more than 0.5 percent per year.

The overall rate of loss in Unit 7 should decrease slowly assuming the continued recent decline in direct man-made loss and the associated loss resulting from alterations to the hydrology. Also, the loss rate will decrease somewhat due to the continued beneficial effects of fresh water and sediment from the

Atchafalaya River. Shoreline erosion will continue to be a major cause of loss in this Unit.

UNIT 8

Location

Hydrologic Unit 8 encompasses the Mermentau Basin which includes the Mermentau River, Grand and White Lakes, and the associated marshes. It shares a common boundary with Unit 7 on its eastern side. The western boundary lies along a line beginning at the Gulf of Mexico approximately 5 miles west of Mermentau River. From there, the line runs north to Louisiana Highway 27. The boundary follows Highway 27 east and north to the Intracoastal Waterway, then west along the Intracoastal to the Calcasieu Locks (Fig. 1).

Geologic Setting

Unit 8 is located in the central portion of the Chenier Plain. This unit is comprised predominantly of fresh and brackish marshes. Saline marshes exist only along the Gulf shoreline and intermediate marshes are found in a narrow band between the fresh and brackish marshes. Man-made features such as Highway 82, Freshwater Bayou, and numerous water control structures play an important role in the distribution of marsh types in Unit 8.

Stranded beach ridges (cheniers), beaches along the Gulf shoreline, and isolated Pleistocene outcrops scattered throughout the interior marshes comprise the only significant natural areas with ground elevations greater than marsh level. Typical geologic profiles in the area show that the subsurface is generally composed of a relatively thin Holocene sequence underlain by Pleistocene deposits. The Holocene is typically composed of soft to medium clay with thin organic zones overlain by approximately 2 feet of organic clay, peat, and marsh. Holocene sediments range from 0 to 30 feet in thickness except in the Mermentau River Entrenchment where thicknesses up to 60 feet are found. Holocene deposits are the result of a combination of riverine and longshore transport processes. The variability of these two processes is responsible for the alternating beach ridges separated by marsh characteristic of the chenier plain. The Pleistocene outcrops just north of the gulf Intracoastal Waterway (GIWW) in most of Unit 8 and just south of the GIWW at Pine and Outside Islands. From there the Pleistocene slopes southward to about -30 feet NGVD at the coast except in the Mermentau River Entrenchment where it varies with the depth of the entrenchment. Holocene sediments deposited approximately

3000 years before present can be found at -6 feet NGVD in the central portion of Unit 8 indicative of the relatively low subsidence rates in this Unit. Average long term relative subsidence rates in Unit 8 are approximately 0.23 ft/century.

Historic Land Loss

The average annual land loss rate increased steadily from 1932 to 1983 in Unit 8. During the 1932 to 1955 period the average rate was 1.55 sq mi/yr. The rate increased to 4.53 sq mi/yr during the 1955 to 1974 period, and peaked at 4.62 sq mi/yr during the 1974 to 1983 period. Since then the rate has decreased to 3.39 sq mi/yr for the 1983 to 1990 period. The average annual percentage of land being lost has followed the same pattern. During the 1932 to 1955 period Unit 8 lost an average of 0.15 percent of the available land area each year. The average yearly percentage increased to 0.46 during the 1955 to 1974 period, and to 0.52 percent for the 1974 to 1983 period. The percentage of land being lost each year decreased to 0.40 during the 1983 to 1990 period (Fig 15). By 1990, Unit 8 had lost approximately 19 percent of the land areas present in 1932. As shown in Figure 15, the majority of this loss occurred during the 1955 to 1983 period. Direct man-made loss accounted for approximately 7 percent of the total loss from 1932 to 1990. Figure 16 shows the average annual percentage of land loss for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 8 for the 1983 to 1990 period. This figure shows that the percentage of land being lost is variable throughout Unit 8. During the 1983 to 1990 period the area around White Lake experienced a high percentage of land loss with the area south of White Lake having a percentage loss rate of over 1 percent per year.

Location of Historic Loss

Areas which have experienced high rates of interior land loss in Unit 8 include:

1. north of the Intracoastal Waterway in and around the Laccasine National Wildlife Refuge
2. between Hwy 27 and Grand Lake
3. east of Grand Lake, between the Intracoastal Waterway and White Lake
4. between Hwy 82 on the north, Lower Mud Lake on the west, the Gulfshore on the south, and the eastern boundary of Unit 8
5. north of Sweet Lake

Some areas where shoreline erosion rates have been especially high include:

1. the Intracoastal Waterway
2. the Gulfshore from south of Lower Mud Lake to just east of Rollover Bayou
3. along the Mermentau River just above Grand Lake

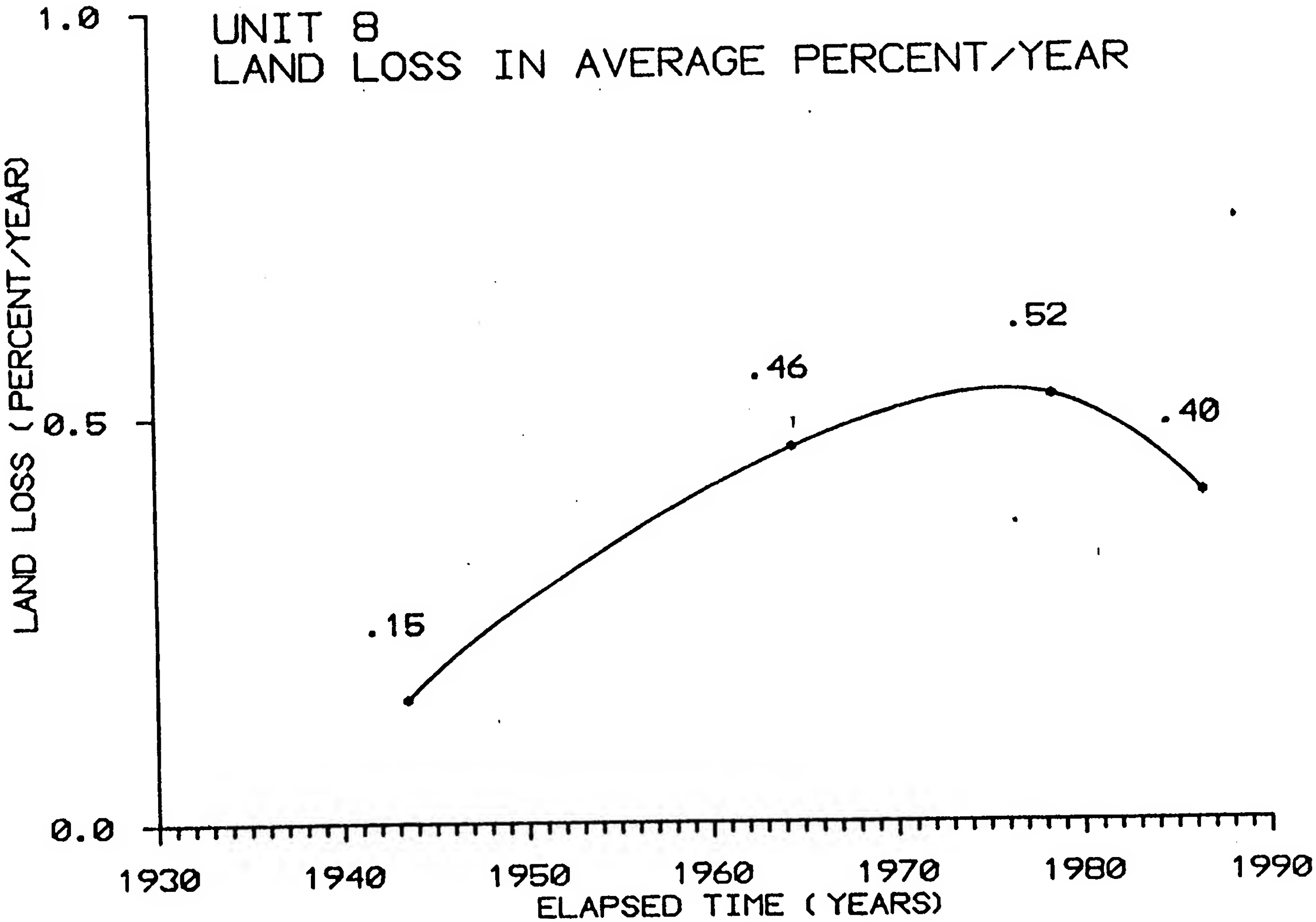

UNIT 8
LAND LOSS IN AVERAGE PERCENT/YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.5
0.0
.15
.46
.52
.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 15.

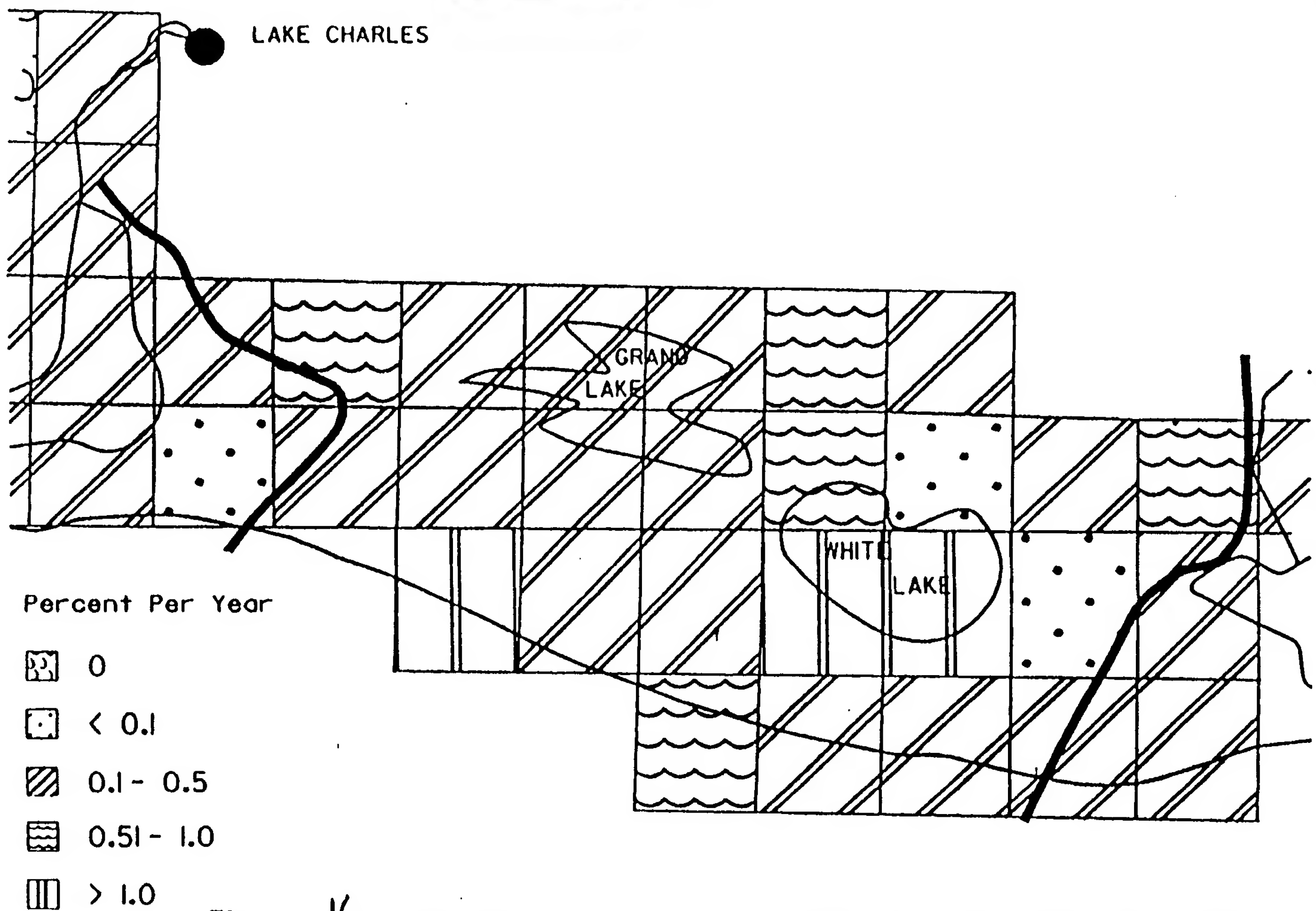


Figure 16. Average annualpercentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

4. the shoreline of Grand Lake, especially Grassy, Tebo, Umbrella, and Short Points, and Rabbit and Bird Islands

5. the shoreline of White Lake, especially on the eastern and southern shores

6. the shores of Lake Misere, Willow Lake, Sweet Lake, and the numerous small lakes between Grand and White Lakes

Some sites where direct man-made loss has been relatively high include:

1. south of Lake Misere
2. east of White Lake
3. southeast of Pecan Island
4. between Freshwater Bayou and Hwy 82

From the available data (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of historic land loss in Unit 8 appear to be shoreline erosion, alterations to the hydrology, and direct man-made loss.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased in Unit 8 since the 1974 to 1983 period. However, this decrease follows a long period of increasing rates (1932 to 1983) and therefore may only reflect a short term change. The main reason for the decrease in rates during the 1983 to 1990 period was a reduction in the rate of loss within the interior marshes.

Some areas where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline from south of Lower Mud Lake to just east of Rollover Bayou
2. the shoreline of Grand and White Lakes especially at the points where the shore protrudes into the lakes
3. the shorelines of smaller lakes such as Cullicon Lake, Lake Misere, Latina Lake and Sweet Lake
4. interior marshes north of White Lake and due south of Pecan Island
5. in the vicinity of Second Lake, south of Grand Chenier Ridge
6. east of Hwy 27 near the Intracoastal Waterway

In the areas identified in 4,5, and 6 above, alterations to the hydrology appear to be responsible for the loss.

Areas where land loss rates have been relatively low but may increase in the near future include:

1) Areas where the eroding lake and Gulf shorelines intersect isolated lakes in the interior marshes. This allows

waves and currents from the large lakes and Gulf to act directly on previously protected interior marshes. Catfish Lake located in the southwestern corner of Grand Lake and Clear Lake located in the northeastern corner of White Lake are examples of this situation related to lakes. Tolan Lake, Big Constance Lake, and Flat Lake are examples of lakes whose shorelines have been or may be intersected by the Gulf shore.

2) Areas where man's activities have led to alterations in the surface hydrology making them susceptible to marsh loss. Examples where this may occur include:

a. southeast of Pecan Island
b. due east of White Lake.
c. south of Lake Misere
d. between White Lake and Freshwater Bayou, south of the Intracoastal Waterway

The direct loss due to dredging activity in Unit 8 has decreased since 1974 and will probably continue to decrease.

Permits

Fifteen marsh management permits have been issued within Unit 8 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects. The areas covered by permit #'s 5, 260, 1, 2, 197, 220, 839, 252, 1014, and 906 have experienced relatively high rates of interior marsh loss. Permit #'s 260 and 220 also have had relatively high man-made loss. In the area covered by permit #1, most of the loss occurred prior to 1955. The area covered by permit #1014 is contained within the boundaries of #5. Moderate interior and man-made loss has occurred in the area of Permit #200. The interior loss in all of these permitted areas appears to be related to alterations to the hydrology; especially those which lead to impoundment, increased tidal exchange, or salt water intrusion or some combination of all three. Therefore, any projects planned for these areas should consider the ability to control relative water levels.

The areas included in permit #'s 7, 151, 710, and 770 have experienced minimal loss in the past 60 years.

CWPPRA

The restoration plan developed under the CWPPRA for the Mermentau Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Mermentau Basin follows the same boundaries as Unit 8. As summarized from CWPPRA, the primary causes of wetland loss in the Mermentau Basin are prolonged flooding, salt water intrusion, and tidal scour, all of which have resulted from alterations to the hydrology. Roads, levees, control structures,

navigation channels, and canals are examples of alterations which influence the hydrology in this Basin.

Strategies developed to preserve and restore wetlands in this basin include:1) reduce inundation in the Lakes Subbasin by managing water levels with existing structures; 2) reduce inundation in the Lakes Subbasin by developing additional outlets to the lakes; 3) reduce saltwater intrusion in the Chenier Subbasin by using water evacuated from the Lakes Subbasin; 4) utilize small scale measures to preserve or restore marsh in areas of critical need or opportunity; and 5) preserve the geologic framework of the Basin by shoreline and bank protection. Figure shows the location of the proposed marsh management projects in Unit 8 from the CWPPRA Plan.

The areas covered by proposed projects XME-46, PME-14, and ME-2 have experienced relatively high rates of interior marsh loss. PME-14 covers the same area as permit #1014 which was discussed previoysly. PME-15, XME-45, and XME-40 are characterized by relatively moderate rates of interior marsh loss. Most of the loss in XME-46, PME-15, and ME-2 occurred prior to 1974. Most of the loss in XME-45 has occurred since 1983. PME-15 has also experienced a moderate amount of man-made loss. In all of the permitted areas, alterations to the natural hydrology appear to be responsible for the observed losses. Measures to reduce flooding and tidal scour should benefit these areas.

The CWPPRA Plan estimates that 39,600 acres (8.6%) of the Basin's existing wetlands will be lost in the next 20 years without project implementation. Much of this loss will occur on the shorelines of Grand and White Lakes, the banks of the GIWW and Freshwater Bayou, The Gulf shoreline, and the interior marshes in the Deep Lake, Freshwater Bayou, and Little Pecan Bayou areas. Interior losses will also occur south of Pecan Island and Grand Chenier.

<u>Summary</u>

From the available information relative to land loss in Unit 8, it appears that alterations to the surface hydrology and shoreline erosion are the dominant processes influencing the land loss rate in this area.

As shown in Figure 16, during the 1983 to 1990 period the percentage of land being lost on individual 7.5 minute quadrangle units is highly variable. The percentage of land being lost ranges from less than 0.1 percent to over 1.0 percent per year. The majority of Unit 8 was losing land at a rate between 0.1 and 0.5 percent per year.

The overall rate of loss within Unit 8 should remain approximately the same or decrease slowly assuming the continued recent decline in man's activities (dredging of canals and construction of roads and levees) within the wetlands.

Unit 9

Location

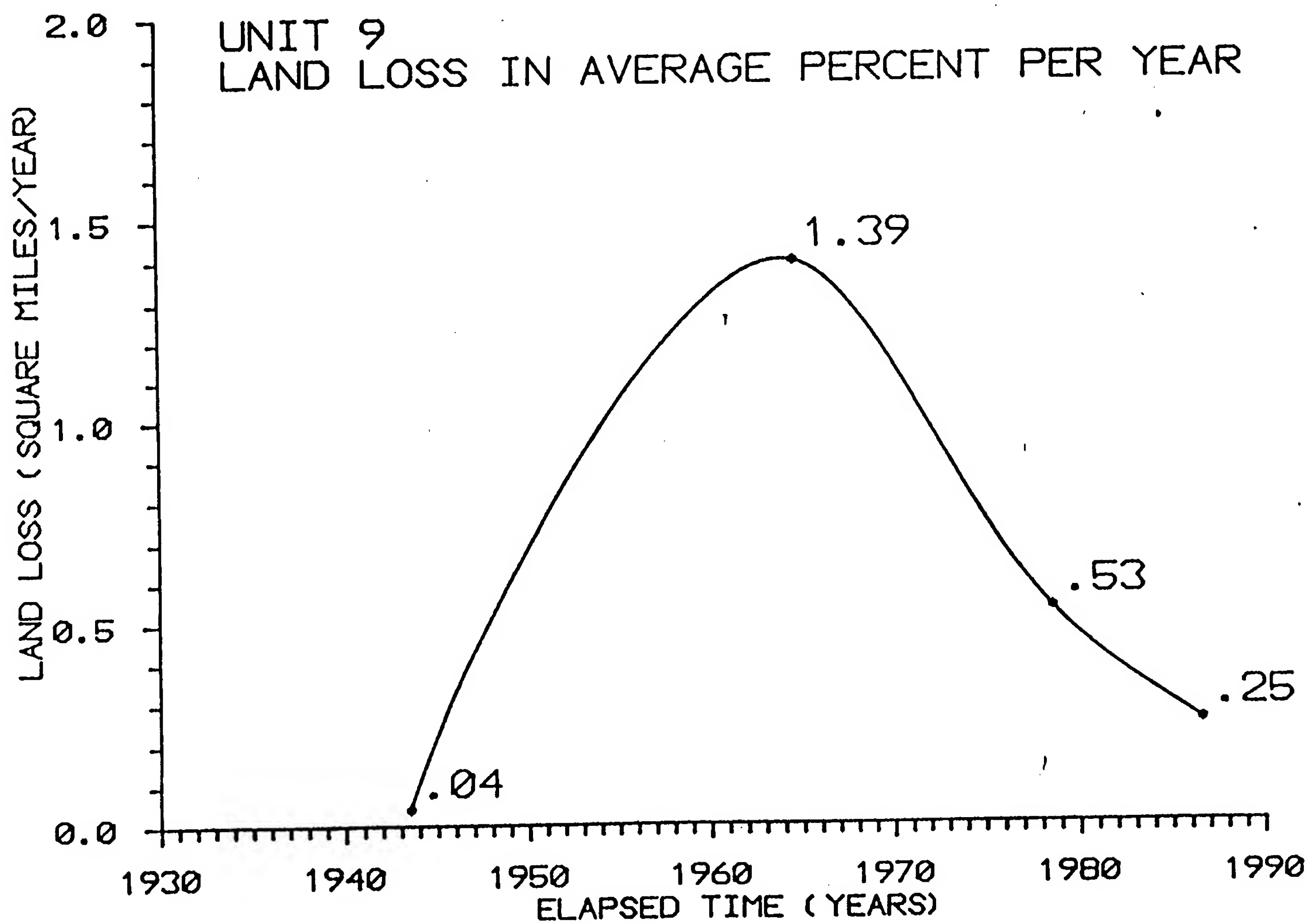
Hydrologic Unit 9 is located in the western half of Cameron Parish and includes the area drained by the Calcasieu and Sabine Rivers. It shares a common boundary with Unit 8 on its eastern side. Its western boundary follows the Louisiana State Line in the Sabine River and Lake (see Figure 1).

Geologic Setting

Unit 9 is located in the extreme western portion of the Chenier Plain. This unit contains fresh, intermediate, brackish, and saline marshes. Man-made features such as navigation channels, access canals, levees, and roads play an important role in the distribution of marsh types in Unit 9. Hackberry Dome, stranded beach ridges (cheniers) and beaches along the Gulf shoreline comprise the only significant natural areas with ground elevations greater than marsh level. Typical geologic profiles in the area show that the subsurface is composed of a thin Holocene sequence underlain by Pleistocene deposits. The Holocene is typically composed of soft to medium clay with thin organic zones overlain by approximately 2 feet of peat, organic clay, and marsh. Holocene sediments generally range from 1 to 25 feet in thickness except in the Calcasieu River Entrenchment where thicknesses up to 70 feet are found. Holocene deposits are the result of a combination of riverine and longshore transport processes. The variability of these two processes is responsible for the alternating beach ridges separated by marsh characteristic of the chenier plain. Pleistocene deposits are generally very stiff, oxidized clay with low water contents and high compressive strengths. The Pleistocene surface represents the most stable surface in coastal Louisiana. Generally, where the depth to the Pleistocene is shallow (<50 ft) subsidence rates are relatively low. The Pleistocene outcrops near the Calcasieu Locks and south to Willow Lake and at the Hackberry Dome. From these sites the Pleistocene surface slopes gently southward to about -25 feet NGVD at the coast except in the Calcasieu River Entrenchment where it varies with the depth of the entrenchment. Holocene sediments deposited approximately 5000 years before present can be found at -14 feet NGVD on the south shore of Calcasieu Lake indicative of the low subsidence rates in this unit. Average long term relative subsidence rates in this Unit are approximately 0.23 ft/century.

Historic Land Loss

The average annual land loss rate for the 1933 to 1955 period was 0.26 sq mi/yr. The rate increased dramatically to 7.98 sq mi/yr during the 1955 to 1974 period and then decreased almost as dramatically to 0.94 sq mi/yr during the 1983-1990 period. The


UNIT 9
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS (SQUARE MILES/YEAR)
2.0
1.5
1.0
0.5
0.0
1.39
.53
.25
.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

F. 17

verage annual percentage of land being lost has followed the same pattern (Fig. 17). The percentage of land lost reached a maximum of 1.39% per year during the 1955 to 1974 period and has since decreased to 0.25% per year for the 1983 to 1990 period. By 1990, Unit 9 had lost approximately 32% of the land area present in 1933. Only Unit 3, located at the mouth of the Mississippi River, has lost a greater percentage of its 1930's land area. Direct man-made loss accounted for approximately 2% of the total loss in Unit 9 during the 1933 to 1990 period. Like most of the hydrologic units in coastal Louisiana, most of the land loss occurred during the 1955 to 1974 period. Approximately 82 percent of the total loss in Unit 9 occurred during the 1955 to 1974 period. Figure 18 shows the average annual percentage of land lost for each of the 7.5 minute quadrangles approximating Unit 9 for the 1983 to 1990 period. This figure shows that the percentage of land lost during the 1983 to 1990 period generally falls between 0.1 and 0.5 percent per year.

<u>Location of Historic Loss</u>

Some areas which have experienced especially high rates of interior marsh loss in Unit 9 include:

1. south of Grand Lake Ridge between Calcasieu Lake and the Intracoastal Waterway
2. adjacent to Hwy 27 in the vicinity of Broussard and Boudreaux Lakes
3. south of Calcasieu Lake, north of Back Ridge
4. west of Calcasieu Lake in the vicinity of Browns and Black Lakes
5. west of Mud Lake adjacent to East Bayou
6. between Starks Central and Starks North Canals
7. west of Burton Sutton Canal, east of Sabine Lake

In these areas, surface landscape features (both nayural and man-made) appear to be highly correlative with interior land loss. These features alter the natural hydrology leading to high relative water levels, restricted surface flow, reduced sediment transport, saltwater intrusion, and tidal scour.

Some areas where shoreline erosion has been especially high include:

1. the Gulf shoreline, especially in the vicinity of the Calcasieu Ship Channel and Peveto Beach
2. the eastern shoreline of Calcasieu Lake
3. the banks of the Intracoastal Waterway

Some sites where direct man-made loss has been relatively high include:

1. east of Black Lake
2. near the intersection of Starks South Canal and Old North Bayou

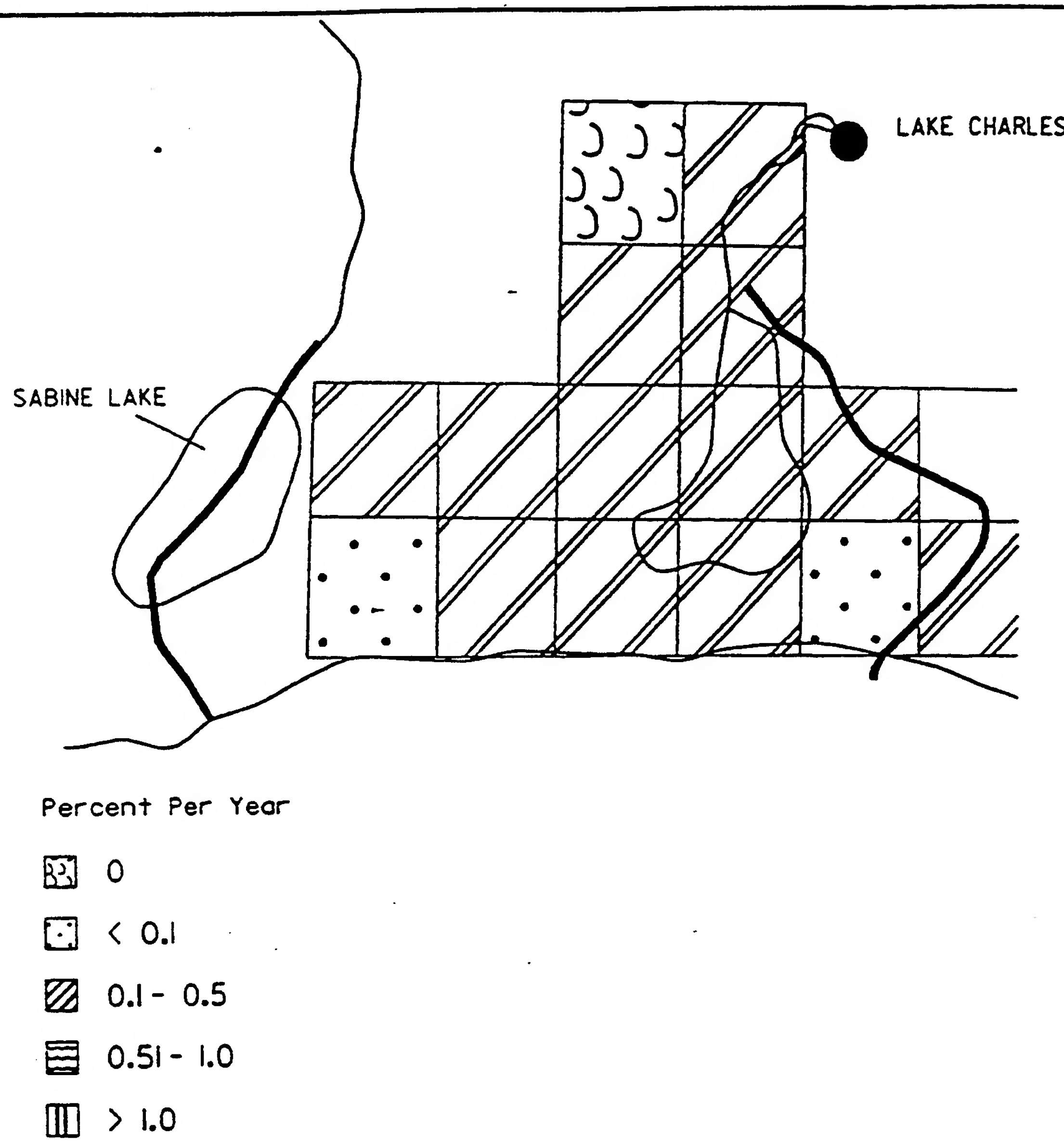


Figure 17. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

From the available data (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of land loss in Unit 9 appear to be alterations to the hydrology and shoreline erosion.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased significantly in Unit 9 since the 1955 to 1974 period. The main reason for this decrease was the dramatic reduction in land loss within the interior marshes. This reduction may be due to several factors. First, the marsh areas most susceptible to changes in relative water levels (i.e. slightly lower ground elevations) and salinity changes were lost rapidly. Since then, land is still being lost, but at a slower rate. Second, many of these areas are intensively "managed" and as management techniques have improved, and problem areas addressed, the resulting loss has decreased. Third, during the 1955 to 1974 period several hurricanes and flooding events occurred that may have been responsible for much of the land loss which occurred during this period.

Some sites where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline immediately west of the Calcasieu Ship Channel
2. the marshes in the vicinity of Boudreaux Lake
3. between the south shore of Calcasieu Lake and Back Ridge
4. west of West Cove on Calcasieu Lake
5. north of the Intracoastal Waterway, north of Black Lake
6. between Mud Lake and the Calcasieu Ship Channel
7. between Hamilton Lake and Starks South Canal

At sites 2 through 7, alterations to the hydrology appear to be responsible for most of the loss in these areas.

The physical erosion of marshes by wave and current action will likely increase as the size of open water areas in the interior marshes increases.

The direct loss due to dredging activity in Unit 9 has decreased since 1974 and will probably continue to decrease.

Permits

Eleven marsh management permits have been issued within Unit 9 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects.

The areas covered by permit #'s 382, 30, 7, 744, 863, 963, 832, 20051, and 923 have experienced relatively high rates of interior marsh loss. The loss in these areas appears to be related to alterations in the natural hydrology; especially those

which increase relative water levels, allow tidal scour, or lead to salt water intrusion. Therefore, the ability to control relative water levels should be considered as part of any project planned for these areas. In the areas covered by permit #'s 30, 744, and 832, it is possible that subsidence related to development around the Hackberry Dome may be responsible for some of the loss in these areas.

The areas included in permit #'s 67 and 611 have experienced little or no loss in the past 60 years.

CWPPRA

The restoration plan developed by CWPPRA for the Calcasieu/Sabine Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Calcasieu/Sabine Basin follows the same boundaries as Unit 9. As summarized from CWPPRA, wetland loss within the basin is largely the result of extensive hydrologic alterations to the wetland building and maintenance functions; especially those which lead to salt water intrusion and tidal scour.

Strategies developed to preserve wetlands in this basin include: 1) preserve marshes by decreasing saltwater intrusion and detrimental water circulation patterns with locks in the major waterways; 2) preserve marshes by decreasing saltwater intrusion and detrimental water circulation patterns at the basin perimeter; and 3) maintain the geologic framework of the basin.

Figure shows the location of the proposed marsh management projects in Unit 9 from the CWPPRA Plan. The areas covered by proposed projects SO-3, SO-5, SO-6, SO-8, SA-1, SA-3, SA-4, SA-5, SA-6, SA-7, CS-10, CS-14, XCS-44, NO-1, NO-2, NO-2A, NO-3, NO-4, NO-5, NO-8, NO-14A, and PCS-25 have all experienced relatively high rates of land loss since the 1950's. Surface landscape features (roads, levees, canals, navigation channels, cheniers, and Pleistocene outcrops) appear to be highly correlative with this loss. Most of these projects involve some type of barrier designed to restrict free water exchange and reduce saltwater intrusion. One problem with these types of projects is the difficulty in maintaining favorable water levels within the managed areas. High relative water levels may lead to marsh loss or make restoration of marsh areas difficult.

The areas included in project #'s SO-4, SA-2, and SO-1 have experienced relatively low rates of land loss since the 1930's. However, these areas can be characterized as having altered hydrology just as those areas previously discussed and may experience the similiar problems in the near future.

The Corps GIS does not contain land loss data on project #'s NO-13, NO-14, NO-15, NO-17, NO-19, NO-20, NO-21, CS-5/A/12, XCS-48, PSC-10, SO-1A, and SO-2. Therefore these areas could not be characterized relative to historic loss. However, surface landscape features in these areas are similiar to those described

previously and the same processes are probably responsible for the losses in these areas.

The CWPPRA Plan estimates that 21,900 acres (approximately 9%) of the Basins existing wetlands will be lost in the next 20 years without implementation of proposed projects. The landscape will evolve into a system dominated by large water bodies of open, relatively turbid water. Physical erosion around the perimeters of these open water bodies will increase.

<u>Summary</u>

From the available information relative to land loss in Unit 9, it appears that alterations to the hydrology and shoreline erosion are the dominant processes influencing the land loss rate in this area.

As shown in Figure 18, during the 1983 to 1990 period most of Unit 9 lost between 0.1 and 0.5 percent of its available land area each year. Since much of the loss in Unit 9 appears to be related to man's activities (i.e. dredging of canals and building of roads and levees) it is difficult to predict the trend in future loss rates. However, assuming the continued recent decline in man's activities within the wetlands the overall rate of loss should continue to decrease slowly. The shorelines of all existing water bodies will continue to erode at varying rates depending on the materials being eroded and the frequency and magnitude of storm events (both winter and summer). If water levels are artificially high within the areas of altered hydrology shoreline erosion rates as well as overall loss rates will increase rapidly.

E - Fish

The reader is strongly encouraged to refer to

4.3.5.2.3. Fish, in the main text.

One group tends to inhabit tidal pools, grassbeds and the marsh surface and edge, eat small animals from the plankton and benthic communities, and reside in the marsh all year long. Killifishes (e.g. Fundulus spp.) and silversides (e.g., Menidia spp.) are examples.

A second group tends to swim in schools and throughout the water column and undertake migrations. Two feeding strategies are prominent. Menhaden (Brevoortia sp.) is a good example of the group that preys on planktonic forms and inhabits the nearshore open waters of the Gulf as adults but as juveniles enter and use the marsh as a nursery area. The feeding strategy of the second group is to prey upon other fish, including other members of its own group, and roam the open ocean throughout their life.

The third group is the bottom fish. Members of this group forage near or along the pond or open water bottoms in marshes or shorelines or other water bottoms. Many are generalists, opportunistically ranging for food that may consist of benthic worms, small fish and scavenging. Others, like the flounders (e.g., Paralichtys sp.) may seek food or bury in the mud awaiting food in the form of shrimp, small crabs, worms, and other fish to pass by. Still others (mullet, Mugli spp.; gizzard shad, Dorosoma) appear to range widely, in loose schools, even though they may actively consume detritus in large amounts for food. Other loosely schooling coastal marsh users (e.g. the sea trouts, Cynoscion spp.; red drum, Sciaenpus sp.) actively seek and prey upon shrimp and other fish (like menhaden). Reproductive movement patterns of this group, like shrimp, involve a movement by nearly mature or fully mature individuals from the marsh to nearshore Gulf waters where breeding occurs. Juvenile forms, often planktonic in size, begin to appear in the bays, shallow waters and marshes of the coast as early as late winter and continue through summer. Once there, maturation continues. Some species return to the nearshore Gulf waters the following summer through fall before reaching full maturity. Others linger longer, returning to the Gulf only as breeding adults.

The reproductive and feeding movements of many fish species are influenced by different factors at different life stages. Tides and winds strongly influence reproductive movements from the Gulf to the marshes. Once in marsh nursery areas and capable of swimming, species distributions appear to be related to water depth, tidal direction, salinity and turbidity. They may also be behaviorally

mediated. Daily feeding movements appear to be triggered by the direction and movement of the tides, winds and short-term meteorological conditions. Reproductive and migratory movements by more mature forms and adults in the fall appear to be triggered by water temperature and salinity. These movements suggest an active response to gradients.

Turner (1977) described a positive mathematical relationship between commercial penaeid shrimp harvests and the area of estuarine intertidal vegetation. The area, average depth or volume of estuarine waters did not seem to contribute to the relationship and the role of aquatic vegetation was undetermined. Turner and Rao (1990) concluded that, even with regional variation, canal embankments and marsh losses were directly related. Peterson and Turner (1994) reported that resident and transient species frequented the shallow waters within 10 feet of the marsh edge as well as the marsh surface several feet in from the edge when tides permitted in a relationship that they suggested could be correlated with predator prey relationships. They made no distinction between a stable marsh edge or marsh edge that arises as a result of erosion. However, given the historic losses and the prospect for continued marsh losses, the marsh edge will continue to be a resource that exists in abundance.

The focus of that designed, manipulative research was on quantitatively characterizing the effects of one particular kind of water control structure on fisheries in an area subject to AMM. That interest emerged in response to academic curiosity and concern about the potential for possible system-wide effects of using certain management practices and structures as well as a desire to know the effects on commercially and recreationally important fishery species. Comparably detailed studies involving other structures and forms of management have yet to be accomplished.

F - Birds

Literature Cited in this Appendix is presented at the end

The standard reference for bird distribution in Louisiana is the somewhat dated Louisiana Birds (Lowery 1974). A revised version is in preparation by other authors. A useful reference for basic data on all coastal species is The Birder's Handbook (Erlich et al., 1988). Brief summaries of basic breeding data, nest site and description, diet, conservation, and pertinent references are listed. More useful is the in-progress species by species reports of The Birds of North America (1993 onward). Published as stand-alone summaries of each species' natural history, this partially completed work incorporates the latest findings on habitat, breeding phenology, demography and populations, conservation, management, and references.

A Louisiana Breeding Bird Atlas showing distribution of all breeding birds in the coastal zone is in the early stages of preparation. Hamel's 1992 The Land Manager's Guide to the Birds of the South briefly summarizes the key habitats, sample breeding densities, food habitats, and pertinent references for all breeding species of Louisiana coastal birds. Charts showing favored water types (fresh, brackish, salt, all) for all species is particularly valuable for marsh managers. Buckley and Buckley (1976) set down guidelines for the protection and management of colonially nesting waterbirds including herons and tern colonies. Recommendations for colonies in marshlands include control of aquatics and emergents by water level manipulation, eradication of aggressive monocultures like *Phragmites* unless known to be used by colonial waterbirds, and maintenance of water levels to provide proper depths for foraging and for preservation of important prey species of fishes and invertebrates. Additional guidelines include differential seasonal regulation of water levels for migrating shorebirds and waterfowl, preventing water from getting so high that it kills important trees or plant species or covers islands, and control of Ph, salinity, aquatic, and emergent plants to maximize their value to colonial birds and their prey species.

Specific species needs include 6-8 inches of water in coastal marshes for foraging white-faced ibis for southwestern Louisiana, preservation of thickets near a body of water for breeding areas for glossy ibis in southeastern Louisiana, marshes with tall herbaceous vegetation for least bitterns in fresh water marshes, elevated perches in trees or shrubs for nesting and roosting neotropical cormorants, shallow water feeding areas in salt or brackish marshes for roseate spoonbill foraging, and 6-10 inches deep shallow fresh water areas for feeding wood storks. Other key

habitat requirements include open fresh water with marshy vegetation along the shores for common moorhens, freshwater marshes with floating and emergent vegetation for purple gallinules, thick herbaceous cover in semi-moist places and at times in dry areas for wintering yellow rails, and dense herbaceous cover of marshes or wet meadows for black rails. Martin and Lester's 1990 work show the location of all known wading bird and seabird colonies in coastal Louisiana on US Geological Survey Quads and species composition of the colonies.
A regional study useful for waterbird data in the Marsh Island area was published by the U.S. Fish and Wildlife Service in 1983. Data on bird distribution, abundance, seasonal occurrence,
and habitat use were derived from aerial surveys. Information on reproduction, behavior, and potential impacts of Outer Continental Shelf development are also discussed. A 1985 work (Louisiana Universities Marine Consortium) looked at the long-term effects of off shore oil and gas development on wetlands including bird populations. Study results discussed effects of oil fouling on birds and the effects of noise and other physical disturbances on birds. The U.S. Fish and Wildlife Service has published a series of habitat suitability index models designed for a wide variety of planning applications where habitat information is an important consideration in the decision process. Relevant published bird models include: great egret, roseate spoonbill, white ibis, great blue heron, lesser snow goose (wintering), greater white-fronted goose, mallard (LMV-wintering), mottled duck, northern pintail (gulf coast wintering), blue-winged teal. lesser scaup (wintering), redhead (wintering), bald eagle, clapper rail, laughing gull, least tern, Forster's tern (breeding), belted kingfisher, and red-winged blackbird.

Clapp's 1982 Marine Birds of the Southeastern United States and Gulf of Mexico Part I Gaviiformes through Pelicanformes notes the preferred breeding and feeding habitat for a few Louisiana breeding waterbirds including pied-billed grebe and neotropical cormorant. He notes that the neotropical cormorant fed mostly on fish that characteristically prefer protected inshore waters to open lake waters. Chabreck (1963) looked at breeding pied-billed grebes on a Louisiana impoundment. He found that most nests (52%) were in open water, the rest (46%) in small stands of wiregrass (*Spartina patens*). Distance to the nearest stand of dense emergent vegetation averaged 60 meters with a range of 1-183 m.

Stutzenbaker (1988) found the most commonly used breeding habitat for coastal breeding mottled ducks was an association of smooth and rough cordgrass dominant over other grasses. Areas with the highest nest densities were

the well-drained cordgrass ridges located immediately adjacent to the permanently wet marsh. The second most productive nesting area was the cattle-pasture and rice production zone, typified by a mixture of prairie grasses dominated by smutgrass, paspalum, and bluestem. Pastures with suitable nesting cover are widely interspersed across the large inland prairie zone, and light to moderate nesting activity occurs wherever there is adjacent surface water. The most desirable water areas in the prairie sites are the natural shallow depressions called "sennabean ponds." These shallow, temporary prairie ponds hold water during wet periods and offer all necessities for breeding, brood rearing, and molting. Osborn (1983) specifically looked at mottled duck nesting and brood rearing habits in Cameron Parish.

Erskine's (1971) monograph on buffleheads identified favored wintering habitat in coastal areas as "shallow waters over mud flats exposed at low tide." Other favored habitats included broad, sandy bays, the upper end of which terminated in a shallow slough about 18 inches deep and the quiet, shallow (3-10 feet) water, over soft bottoms, of reaches, sheltered coves, and bays.
Paulus (1984) looked at activity budgets of non-breeding gadwalls in Louisiana marshes. Gadwalls rarely left foraging sites during day or night except when disturbed or during hunting season. Hunting in marshes around the Rockefeller Refuge forced many gadwalls to leave these marshes during the day and use impounded marshes on the refuge. His thesis (1980) looked at the wintering ecology of the gadwall in Louisiana. Swiderek (1982) investigated waterfowl usage of three specific plants including sea purslane, Gulf Coast muskgrass, and wigeongrass in brackish impoundments in coastal South Carolina and notes that sea purslane is managed in Louisiana. Sea purslane offers managers a viable alternative to wigeongrass and an opportunity to increase diversity of food and waterfowl species.

The Waterfowl Management Handbook (Cross, 1988) offers species-specific summaries of breeding/wintering habitat for a variety of ducks and geese that winter in Louisiana. In Marine Birds of the Southeastern United States and Gulf of Mexico, Part II, Anseriformes,
Clapp et al. describe wintering habitats for 41 waterfowl species which occur in southern Louisiana and include a useful bibliography. Lokemoen and Messmer (1994) discuss the placement, management, and permitting of earthen and rock nesting islands in wetlands for waterfowl, colonial birds, and shorebird breeding sites. Junkin (1989) noted effects of various water regimes upon waterfowl food plants. Carloss (1988) looked at the diversity and relative abundant

of avian species on Marsh Island, Louisiana. Abernethy (1986) researched the specific restoration practice of backfilling old pipeline canals and its effect upon both environmental conditions and waterfowl usage. The quantity and quality of waterfowl habitat in Louisiana was addressed by Williams and Chabrack (1986). Bettinger's thesis (1984) focused on the relative abundance of avian species by habitat on the Rockefeller Wildlife Refuge. Nassar (et al., 1988) noted that brown seed millet rather than rice was the best forage for wintering waterfowl in rice fields but that rice attracted substantial numbers too and would obviously be favored by farmers. Heavy night use of rice fields by large flocks of wood ducks was an interesting sidebar to this study.

Dugoni (1975) looked at breeding habitats of bald eagles in forested wetlands just north of the coastal marshes in Louisiana. He found that eagles do not prefer certain nesting territories based on surrounding habitat availability alone. Dominant prey items included freshwater catfish and American coots indicated the importance of an abundance of wintering waterfowl and shallow lakes within the coastal zone.

Helmers (1992) notes that migrant and wintering shorebirds in the coastal areas exploit hypersaline lagoons, freshwater marshes, coastal beaches, deltas, shallowly flooded agricultural fields, and hypersaline tidal flats. Microhabitat requirements range from unvegetated mudflats to moderately vegetated open shallows (up to 15 cm). Managing shorebirds in the Gulf region should focus on protecting natural habitats used by migrating and breeding shorebirds, reducing disturbance, and enhancing habitats in managed wetlands. Timed drawdowns to expose flats or shallows during peak migration periods has been utilized on several state and federal refuges in the region, generally from mid-April to 1 June and from 10 July through October.

White and James (1978) note requirements of wintering coots in coastal southeastern Texas adjacent to Cameron Parish, Louisiana. On average, coots fed in areas that were 90 cm deep with 20% cover of emergent vegetation and 40% cover of floating plus submerged vegetation. Hydrilla (*Hydrilla verticillata*) was noted as an important component of wintering habitat in both Florida (Hardin et al., 1984) and Texas (Esler 1990). Tacha and Braun (1994) delineate coastal habitat needs of wintering and breeding gallinules and rails. Purple gallinules breed primarily in fresh to intermediate salinity (less than 5 ppt. salt content) marshes. Deep water marshes (0.25-1 m depth), lakes, and impoundments (primarily coastal, but also inland), with stable water levels and dense stands of floating, emergent

and submergent vegetation provide excellent habitat for nesting gallinules. An additional study on nesting gallinules, their home range, and habitat selection in freshwater areas is Matthews (1983) thesis. Optimal habitat for clapper rails is low tidal salt marsh (low being defined as sites flooded at least once daily during high tide) dominated by cordgrass of moderate height and salinity levels exceeding 7,100 ppm at low tide and 5,600 ppm at high tide (Meanley 1985). Sharpe (1976) found Louisiana clapper rails were most abundant in dense smooth cordgrass.

Meanley (1969) found that the marshes of the deltaic and Chenier plains of the Gulf coast are the most important coastal wetlands for king rails. On intensively managed refuges, a complex of wetland units should include marsh habitats that naturally dry during the summer and may include extensive perennial vegetation (Reid 1993). Helm (1982) made a thorough study of nesting chronology of both common moorhens and purple gallinules in southwestern Louisiana.

Marine Birds of the Southeastern United States and Gulf of Mexico, Part III, Charadriiformes, delineates preferred breeding and wintering habitat for 22 species of gulls, terns, and skimmers found in southern Louisiana (Clapp et al., 1983). A bibliography is included. Soots, Jr. and Landin 1978) discuss the development and management of avian habitat on dredged material islands. There is a brief discussion of wetland plants and plant succession on these islands and a bibliography with several references to dredged material placement in wetlands.

A growing body of literature addresses the issues of trans-Gulf passerine migration, the decline in wintering/migratory habitat, and habitat fragmentation. Finch's 1990 report summarizes recent literature on population trends of neotropical migrants and the factors affecting migrant populations on the breeding and wintering grounds. Willow and other tree stands in Louisiana's southern marshes are often the first/last foraging grounds for trans-Gulf migrants. Research on bird usage of these habitats is currently underway at Sabine National Wildlife Refuge and other sites, but results as yet are unpublished. Sidney Gauthreaux (in press) has researched compared radar imagery from the 1980's with 1960's data and has found significant declines, particularly in early migration species (March 15-21), several of which utilize marsh-edge habitats.

The Handbook for Nongame Bird Management and Monitoring in the Southeast Region (1990) discusses habitat requirements, monitoring techniques, and conservation issues associated with 14 southeastern nongame species. Species accounts

applicable to this paper include least and American bitterns, reddish egret, black rail, gull-billed tern, barn owl, bewick's wren, and seaside sparrow. The summary of major wetland legislative documents and their relation to wetland birds is highly useful. The publication notes the total lack of information on habitat requirements for the two bittern species, but does recommend experimenting with fires to create greater diversity of emergent species. Moist soil management, which includes a shallow perimeter where saltgrasses, rushes, or sedges can grow and careful attention to flooding schedules, provides important habitat for the black rail, probable resident of coastal Louisiana. Population declines in seaside sparrows may be due to subtle ecosystem changes unknown at present.

Historically, Sprunt (1967) presented a commentary on how waterfowl and several major bird groups are dependent upon the South Atlantic and Gulf Coast marshes and estuaries. Palmisano (1972) reported on the distribution of several recreationally and commercially important species that served as indices of the relative abundance of the total abundance of birds and mammals. His findings were reported by marsh type and region for furbearers (e.g., muskrat, nutria, mink, raccoon,otter) and several species of waterfowl. Spiller and Chabreck (1975) reported higher use by coots, ducks and non-game birds, especially during the winter, because of more stable water levels in ponds behind fixed-crest weirs in otherwise open marshes.

More recently, Chabreck, Joanen and Paulus (1989) presented a general review of considerations and actions for waterfowl management, which largely reflected the historic record. Turner, Day and Gosselink (1989), relying heavily upon the findings of Spiller (1975), reported that management did not reduce wildlife as part of their summary of how several significant resources of Louisiana's coastal marshes have been reported to respond to management.

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G - Threatened and Endangered Species/Marine Mammals

NOTE: Literature citations presented in this Appendix are presented at the end of this Appendix

The response of these species to HM efforts most often must be inferred from biological/ecological profiles. Hence, the following descriptions are based primarily upon respective recovery plans prepared by the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). Portions of this document have been taken from previously written Biological Assessments, including:

1) "Biological Assessment of Threatened and Endangered Species, Houma Navigation Canal, Additional Dredged Material Disposal Areas, Terrebonne Parish, Louisiana" (COE 1991).

2) "Biological Assessment for the Endangered Species, Pallid Sturgeon (Scaphirhynchus albus), New Orleans District, Louisiana" (COE 1991).

3) "Biological Assessment for the Proposed Threatened Species, Gulf Sturgeon (Acipenser oxyrhynchus desotoi)" (COE 1991).

4) "Biological Assessment of Impacts of Proposed Site Designation for Ocean Dredged Material Disposal in Coastal Louisiana, Houma Navigation Canal (Cat Island Pass), Barataria Bay Waterway (Barataria Pass and Bar Channel), and Mississippi River-Gulf Outlet (Breton Sound and Bar Channel)" (COE 1991).

5) "Biological Assessment of Impacts of Shoreline and Barrier Island Restoration Projects Throughout Much of Coastal Louisiana" (nd).

6) "Biological Assessment of Threatened and Endangered Species Barataria Bay Waterway Bar Channel" (nd).

7) "Biological Assessment Wetland Development Along the Barataria Bay Waterway and Restoration of Queen Bess Island, Jefferson Parish, Louisiana" (Klein 1994).

8) "Biological Assessment: Impacts of Navigation Channel Hopper Dredging on Threatened and Endangered Species in Louisiana" (Baird 1995).

9) "Biological Assessment of Threatened and Endangered Species Impacted by Marsh Management Activities (Draft)" (Brantley and Bosenberg 1995).

G.1. Species Profiles

GULF STURGEON (Acipenser oxyrinchus desotoi)

The Gulf sturgeon has been a recognized subspecies of the Atlantic sturgeon since 1985 and inhabits the Atlantic and Pacific oceans and certain freshwaters of the United States. The Gulf sturgeon was officially designated on September 30, 1991, to be a threatened subspecies, pursuant to the Endangered Species Act of 1973, as amended (ESA). According

to the recovery/management plan for the Gulf sturgeon (FWS and NMFS 1995), this andromomous fish inhabits marine waters of the central and eastern Gulf of Mexico south to Florida Bay; and occurs in most major river systems from the Mississippi River to the Suwannee River, Florida. At present, Gulf sturgeon population estimates have been completed only for the Apalachicola and Suwannee rivers; no population estimates exist for this species occurrence in the remainder of its range.

The Gulf sturgeon is an anadramous species, laying eggs in freshwater, moving to the Gulf of Mexico at 3-4 years of age during the fall and winter, and returning to freshwater each spring as river temperatures rise to 16 to 23 °C. According to the Gulf sturgeon recovery/management plan (FWS and NMFS 1995), subadults and adults spend 8 to 9 months each year in rivers and 3 to 4 of the coolest months in estuaries or Gulf waters. Gulf sturgeon less than 2 years old remain in riverine habitats and estuarine areas throughout the year. Wooley and Crateau (1985) found Gulf sturgeon in the Apalachicola River downstream from Jim Woodruff Lock and Dam (river km 171) from May through September. They seemed to concentrate in a large scour hole below the lock, moving very little from the area. The area consisted of sand and gravel substrate, with water depths of 6.0 to 12.0 meters and velocities of 0.6 to 0.9 meters/second. The fish begin to migrate back to estuaries when river temperatures dip below 23 C Wooley and Crateau (1985). The Gulf sturgeon has a strong home-stream tendency (Hollowell 1980; Wooley and Crateau 1985) and will not readily populate another river system.

Gulf sturgeon are omnivorous benthos eaters, consuming insect larvae, molluscs, shrimp, isopods, small fish (Hollowell 1989), crab, amphipods, annelids, lancelets, brachiopods (Mason and Clugston 1993), and vegetable matter (Huff 1975). After five or six years of age, Gulf sturgeon begin to feed almost exclusively in marine or estuarine waters during the winter and live off body fat during summer months (Barkuloo 1988). It remains unclear why most subadult and adult Gulf sturgeon feed in the marine environment for a relatively short time and enter freshwater where they do not feed (USFWS and Gulf State Marine Fisheries Commission 1995).

The Gulf sturgeon can easily attain length over 2m and live nearly 30 years. Huff (1975) found that mature females ranged in age from 8-17 years and that mature males ranged from 7 to 21 years. Chapman found that mature Gulf sturgeon produce an average of 403,000 eggs. Eggs are demersal and adhesive. Timing, location, and habitat requirements for Gulf sturgeon spawning are not well documented.

The Gulf sturgeon was virtually extirpated throughout its range at the turn of the 20th century. Overexploitation, damming of rivers and other forms of habitat destruction, incidental catch, and water quality deterioration are listed as some of the causes of their decline (Huff 1975; Barkaloo 1988; McDowall 1988; and Birstein 1993).

The Gulf sturgeon recovery/management plan describes extant occurrences of Gulf sturgeon both offshore and within Louisiana river basins. Most of these occurrences were incidental takes by commercial fishermen, and included the following areas and (number taken): from shore to 180 ft in an area between Point au Fer, Louisiana and Perdido Bay, Florida (1 juvenile specimen); off the mouth of the Mermentau River (1); at the mouth of the Mississippi River (2) and at river mile 311.0 (1); at river mile 10.0 of the Red River (1); Lake Pontchartrain/Lake Borgne/Rigolets (177+); Tchefuncte River (15+); Tickfaw River (1+); Tangipahoa River (1+); Amite River (1); Pearl River (65+); Middle Pearl River (105+); Bogue Chitto River (3); East Pearl River (2); and West Pearl River (5).

KEMP'S RIDLEY TURTLE (<u>Lepidochelys kempii</u>)

Kemp's ridley was listed as endangered throughout its range December 2, 1970, and has continued to decline in Louisiana (U.S. Fish and Wildlife Service 1990). The recovery plan for the Kemp's ridley sea turtle (FWS and Gulf States Marine Fisheries Commission 1992) indicates that adults of the species occurs mainly in coastal areas of the Gulf of Mexico and northwestern Atlantic Ocean. Little is known of the movements of the post-hatching, planktonic stages within the Gulf. However, juvenile/subadult ridleys in the Gulf typically occupy shallow, coastal regions and may move offshore to deeper warmer water during winter. Post-pelagic stages in the Gulf are commonly found over crab-rich sandy or muddy bottoms. Adults are present seasonally near the Mississippi River mouth and Campeche Banks, converging annually on the single major nesting beach located at Rancho Nuevo on the northeastern coast of Mexico.

The possibility of ridley nesting on the Louisiana coast has been suggested (Viosca 1961), but no actual documentation exists. Although this species once nested on beaches from south Texas to southern Mexico, the Kemp's ridley is now known to nest only on the coastline of the Mexican state of Tamaulipas (USFWS and NMFS 1992). There is some sporadic nesting along the Texas coast. Females arrive in small aggregations known as arribadas from mid-April through August (Rabalais and Rabalais 1980). Based on returns of females tagged on the nesting beach, most adult ridleys move to major foraging grounds to the south in the

Campeche-Tabasco region and some move to the northern Gulf of Mexico (Chavez 1969).

Stomach analysis of specimens collected in shrimp trawls off Louisiana includes crabs (Callinectes), gastropods (Nassarius), and clams (Nuculana, Corbula, and probably Mulinia), as well as mud balls, indicating feeding near a mud bottom in an estuarine or bay area (Dobie et al. 1961). Although considered primarily carnivorous benthic feeders (Ernst and Barbour 1972), jellyfish have also been reported as part of their diet (Fritts et al. 1983). Presence of fish such as croaker and spotted seatrout in the gut of stranded individuals in Texas may suggest that turtles feed on the by-catch of shrimp trawlers (Landry 1986).

This small sea turtle is believed to be the most frequently encountered (Dundee and Rossman 1989), if not the most abundant sea turtle off the Louisiana coast (Gunter 1981; Viosca 1961). The population decline of the ridley has been attributed to predation on eggs by humans, other mammals, birds, and crabs, in addition to the capture of diurnal nesting females. Recent causes of mortality are attributable to fishing activities and accidental capture in shrimp trawls (Pritchard and Marquez 1973; Fuller 1978; USFWS and NMFS 1992). The Kemp's ridley recovery plan (USFWS and NMFS 1992) cites incidental take by the shrimp industry as the largest source of mortality for Ridleys. Shrimpers off the Texas coast, as well as in heavily trawled areas off the coasts and in the bays of Louisiana and Alabama (Dundee and Rossman 1989; Carr 1980; Pritchard and Marquez 1973) contribute to the decline of the ridley. Decline has not been associated with the establishment of MM structures in coastal Louisiana.

Inshore areas of the Gulf of Mexico appear to be important habitat for the Kemp's ridley, as they tend to concentrate around the mouths of major rivers (Frazier 1980). Ridley's genus are characteristically found in waters of low salinity and high turbidity and organic content, where shrimp are abundant (Hughes 1972, as cited in Frazier 1980; Zwinenberg 1977). Kemp's ridleys have been collected in Louisiana from Lake Borgne, Barataria and Terrebonne Bays, and near Calcasieu Pass (Dundee and Rossman 1989).

Although there is a low probability of occurrence, these turtles have a tendency to follow large shrimp concentrations into estuarine marshes and the possibility of incidental interaction with permitted MM activities exists. In addition, HM structures could impact ridley's indirectly by prohibiting the movement of some ridley food items, such as crabs. However, the potential for adverse impacts to the Kemp's ridley population is negligible.

Precise data regarding the total number of Kemp's ridleys occurring in the Gulf of Mexico are not available. Trends in turtle populations are identified through monitoring of their most accessible life stages on the nesting beaches, where hatchling production and the status of adult females can be directly measured. Population declines of the ridley have been attributed to egg stealing on the localized nesting beach, capture of diurnal nesting females, and fishing and accidental capture in shrimp trawls (Fuller 1978; Pritchard and Marquez 1973).

Film taken in 1947 documented over 40,000 nesting females in a single day during an arribada at Rancho Nuevo (Carr 1963). Bi-national protection and monitoring by Mexico and the United States has occurred on the nesting beach since 1978. Arribadas of up to 200 females have rarely been observed since the beginning of monitoring (U.S. Fish and Wildlife Service [USFWS] and NMFS 1992). Nest production plummeted to only 702 nests in 1985, but has been steadily increasing since that time (Byles, pers. comm.). Over 1,500 nests were observed during the 1994 nesting season, representing the highest nesting year since monitoring was initiated. While these data need to be interpreted cautiously due to expanded monitoring efforts since 1990, an estimated 107,687 hatchlings were released from Rancho Nuevo in 1994, compared to 45,000 to 80,000 from 1987 through 1991 (Byles, pers. comm.).

Documented evidence and anecdotal accounts suggest an upward trend in the Kemp's ridley population. However, the Recovery Plan for the Kemp's ridley sea turtle (Lepidochelys kempi) (USFWS and NMFS, 1992) has identified a recovery criteria of 10,000 nesting females in one season as a prerequisite for a determination that Kemp's ridleys can be downlisted to a threatened status. Considering 58 percent of all adult females appear to nest in any one year, and each female lays an estimated 2.7 nests, 1,500 nests documented in 1994 represents less than 1,000 adult female Kemp's ridleys in the entire population. This is less than 2.5 percent of nesting females observed in one day in 1947, and only 5 percent of the downlisting criterion identified in the Recovery Plan.

Inshore areas of the Gulf of Mexico appear to be important habitats for the Kemp's ridley. Members of this genus are characteristically found in waters of low salinity, high turbidity, high organic content, and where shrimp are abundant (Zwinenberg 1977, Hughes 1972). Adults tagged at Rancho Nuevo were recaptured off coastal Louisiana and in Vermilion Bay, and animals have been reported from Vermilion Parish to Terrebonne Parish (Pritchard and Marquez 1973; Chavez 1969; Keiser 1976; Zwinenberg 1977; Dobie et al.

1961). Ridleys are commonly captured by shrimpers off the Texas coast and in heavily trawled areas of the Louisiana and Alabama coast (Pritchard and Marquez 1973; Carr 1980).

Kemp's ridley has been labeled the "Louisiana turtle" by Hildebrand (1981) and is thought to be the most abundant turtle off the Louisiana coast (Viosca 1961; Gunter 1981). The highly productive white shrimp-portunid crab beds of Louisiana from Marsh Island to the Mississippi Delta are thought to be the major feeding grounds for subadult and adult ridley (Hildebrand 1981). The current patterns in the Gulf of Mexico could aid in transport of individuals, where small turtles would enter the major clockwise loop current of the western Gulf of Mexico, carrying individuals north and east along Texas, Louisiana, and other northern Gulf areas (Pritchard and Marquez 1973; Hildebrand 1981).

Beginning in April 1994, unprecedented numbers of dead sea turtles beached along the coasts of Louisiana and Texas. During 1994, a total of 174 turtles, including 134 Kemp's ridleys, stranded in Louisiana. An additional 488 turtles stranded on offshore Texas beaches during 1994, including almost 243 Kemp's ridley turtles and 190 loggerheads. The apparent cause of most of the strandings was the simultaneous occurrence of an intensive pulse of shrimping in an area of high Kemp's ridley abundance during 1994. Information regarding whether the abundance of sea turtles in the northern Gulf was a seasonal anomaly, or represents the current status of sea turtles in nearshore waters, is not available. The Louisiana Sea Turtle Stranding and Salvage Network (LA-STSSN) registered 373 sea turtles stranded on Louisiana beaches from 1990 through 1994. Of these, 268 were Kemp's ridleys, and 41 were unidentified (Koike 1995).

Stomach content analyses on sea turtles stranded in Texas suggest that, in all years, most mortalities occur in nearshore waters. Stomach contents of Kemp's ridleys along the lower Texas coast also showed a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards (Shaver 1991). Over 150 Kemp's ridleys have been intentionally live-captured by research gillnets in 1993 and 1994 at Sabine Pass by Texas A&M University scientists conducting research for the Corps of Engineers. This illustrates the availability of ridleys to human interactions in north Texas waters.

Findings of ongoing research conducted by NMFS scientists support the likelihood that the nearshore waters of Texas and Louisiana provide important developmental habitat for young loggerheads and Kemp's ridley sea turtles. Ogren

(1988) suggests that the Gulf Coast from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. One hundred and thirty turtles have been tracked by NMFS Galveston Lab staff since 1980, including 91 ridleys tracked since September 1988 with Corps support. Preliminary analysis of data collected suggests that subadult Kemp's ridleys occupy shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida Coast (Renaud, pers. comm.). Juvenile ridleys are usually found in waters of 9 meters or less, and all ridleys are generally found in water depths less than 18 meters (Renaud, draft in-house report transmitted December 8, 1994).

In addition to the NMFS studies, satellite transmitters have been applied to approximately 50 adult female Kemp's ridleys over the last decade to identify the movements of the females after leaving the nesting beach in Rancho Nuevo, Mexico (Byles, unpublished data). While most female ridleys head south towards the Bay of Campeche after leaving the beach, two out of eight turtles headed into nearshore Texas waters during one year's study. In 1994, of four turtles that were tagged, three went south and one went as far north as the vicinity of the mouth of the Mississippi River. (Byles, pers. comm.) Clearly, reproductively active Kemp's ridleys, which are directly required for the recovery of the population, are found within the U.S. Gulf of Mexico, and are as vulnerable to human impacts as sub-adults.

LOGGERHEAD SEA TURTLE (Caretta caretta)

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (U.S. Fish and Wildlife Service 1991a) and has continued to decline in Louisiana (U.S. Fish and Wildlife Service 1990). The largest of the hard-shell turtles, the loggerhead is distributed worldwide in temperate and tropical bays and open oceans. Loggerheads probably range all along the Louisiana coast; however, Dundee and Rossman (1989) report specimens only from Chandeleur Sound, Barataria Bay, and Cameron Parish. The population decline of loggerheads can be attributed to egg and nestling predation by mammals and birds (Dundee and Rossman 1989). The loggerhead sea turtle population is not expected to be impacted by permitted HM activities.

The principal nesting range of the loggerhead is from Cape Lookout, North Carolina, to Mexico. The majority (90 percent) of the reproductive effort in the coastal United States occurs along the south-central coast of Florida (Hildebrand 1981). Nesting in the northern Gulf outside of

Florida occurs primarily on the Chandeleur Islands and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi and Alabama (Ogren 1977). Loggerhead eggs were collected from Grand Isle, Louisiana, 50 years ago (Hildebrand 1981). Ogren (1977) reported a historical reproductive assemblage of sea turtles which nested seasonally on remote barrier beaches of eastern Louisiana, Mississippi, and Alabama. This included Bird, Breton, and Chandeleur Islands in Louisiana. Loss or degradation of suitable nesting habitat may be the most important factor affecting the nesting population in Louisiana (Ogren 1977).

Loggerhead turtles are considered turtles of shallow water, less than 50 meters deep (Rabalais and Rabalais 1980). Juvenile loggerheads are thought to utilize bays and estuaries for feeding, while adults prefer waters less than 50 meters deep (Nelson 1986). During aerial surveys of the Gulf of Mexico, the majority (97 percent) of loggerheads were seen off the east and west coasts of Florida (Fritts 1983). Most were observed near mid-day near the surface, possibly related to surface basking behavior (Nelson 1986). Although loggerheads were seen off the coast of Louisiana and Texas, they were 50 times more abundant in Florida than in the western Gulf. The majority of the sightings were in the summer (Fritts et al. 1983). Loggerheads migrate west along shallow coastal waters, as indicated by telemetry data from an individual tagged in the Mississippi Delta moving to Corpus Christi (Solt 1981).

Loggerheads were frequently observed near offshore oil platforms, natural rock reefs, and rock jetties in Texas. Large numbers of stranded turtles were observed inshore of such areas (Rabalais and Rabalais 1980). Oyster fishermen have reported large turtles near oyster reefs in Louisiana. In a recent tracking study, loggerheads spent more than 90 percent of the time underwater, tended to avoid colder water, and spent much of the time in the vicinity of oil and gas structures (Renaud and Carpenter, in preparation).

Food of loggerheads consists of molluscs, crabs, shrimp, sea urchins, sponges, squid, basket stars, jellyfish, and even mangrove leaves in the shallows (Caldwell et al. 1955; Hendrickson 1980; Nelson 1986). Presence of fish species such as croaker in stomachs of stranded individuals may indicate feeding on the by-catch of shrimp trawling (Landry 1986). They appear to be well adapted for feeding on molluscs with a heavy jaw and head (Hendrickson 1980). Caldwell et al. (1955) suggest that the willingness of the loggerhead to consume any type of invertebrate food permits its range to be limited only by the presence of cold water. In shallow Florida lagoons, loggerheads were found during the morning and evening, leaving the area during mid-day

when temperatures reached 31°C. At dusk, turtles moved to a sleeping site and remained there until morning, possibly in response to changes in light or water temperature (Nelson 1986).

Loggerhead turtle strandings have been reported in Louisiana from Cameron (Fuller 1986) as well as Holly Beach in August, and Isles Dernieres in July (SEAN 1980). A tagged loggerhead was recaptured near Grand Isle at Belle Pass (Lund 1974). More recently, LA-STSSN registered 45 loggerheads stranded on Louisiana beaches from 1990 through 1994. This represented 12 percent of the sea turtles stranded, second only to the Kemp's ridley. Studies conducted on loggerheads stranded on the lower Texas coast (south of Matagorda Island) have indicated that stranded individuals were feeding in nearshore waters shortly before their death (Plotkin et al. 1993). Recent capture and telemetry studies of sea turtle movements along the northern Gulf of Mexico showed usage of the nearshore areas near jetties and channels. Kemp's ridleys were captured most frequently, and loggerheads were the second most frequently captured in Texas and Louisiana waters.

Nesting on the Gulf Coast occurs between the months of April and August, with 90% of the nesting effort occurring on the south-central Gulf Coast of Florida (Hildebrand 1981). Although loggerheads have been documented as nesting on the Chandeleurs in 1962 and Grand Isle in the 1930's, it is doubtful whether this species currently nests on the Louisiana coast (Hildebrand 1981, Dundee and Rossman 1989).

ATLANTIC GREEN SEA TURTLE (Chelonia mydas)

Populations in Florida and on the Pacific coast of Mexico are federally listed as endangered; all other populations are listed as threatened (NMFS and USFWS 1991). Green turtles current status in Louisiana is unknown (USFWS 1990). It is a large sea turtle with carapace length in adults commonly reaching one meter (NMFS and USFWS 1991). The green turtle has world-wide distribution, concentrated primarily between 35° North and 35° South latitude.

Green turtles tend to occur in waters that remain warmer than 20°C; however, there is evidence that they may be buried in mud in a torpid state in waters to 10°C (Ehrhart 1977; Carr et al. 1979). Although green sea turtles are found world wide in oceans and gulfs with water temperatures greater than 20°C, their distribution can be correlated to grassbed distribution, location of nesting beaches, and associated ocean currents (Hirth 1971). Often long migrations are made between feeding and nesting grounds

(Carr and Hirth 1962). Within Louisiana waters, these turtles probably occur all along the coast and may nest on the Chandeleur Islands (Dundee and Rossman 1989). During their first year of life, green turtles are primarily carnivorous, feeding mainly on invertebrates. As adults they feed almost exclusively on seagrasses growing in shallow water flats (Fritts et al. 1983a), but also feed on invertebrates and carrion (Dundee and Rossman 1989).

Historical sightings of green turtles by fishermen in Louisiana occurred gulfward of Isles Dernieres and Timbalier Islands in spring, summer, and fall. Recent sightings have been reported from the northwest areas of Terrebonne Bay in summer and off Belle Pass in fall (Fuller 1986). A green turtle also has been reported from the Chandeleur Islands (Viosca 1961). A green turtle was found in June on Grand Terre near Fort Livingston (SEAN 1980). No green turtles were observed during an aerial survey in Louisiana or Texas in 1979, possibly due to low abundance as well as identification problems. Green turtle stranding records, and turtle fishing records from Louisiana and Texas combined, are one-third that reported from Florida (Fritts et al. 1983). LA-STSSN registered 10 green turtles stranded on Louisiana beaches from 1990 through 1994. This represented 2.7 percent of the sea turtles stranded.

In the United States, Atlantic waters, green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida. During their first year of life, green sea turtles are thought to feed mainly on invertebrates, with adults preferring an herbivorous diet and frequenting shallow water flats for feeding (Fritts et al. 1983). The adult turtle feeds primarily on seagrasses (i.e., *Thalassia testudinum* and turtle grass), which has a high fiber content and low forage quality (Bjorndal 1981a) and algae (Bjorndal 1985). The Caribbean green turtle is considered by Bjorndal (1981b) to be nutrient-limited, resulting in low growth rate, delayed sexual maturity, and low annual reproductive effort. This low reproductive effort makes recovery of the species slow once the adult population numbers have been severely reduced (Bjorndal 1981). In the Gulf of Mexico, principal "feeding pastures" are located in the upper west coast of Florida (Hirth 1971). Nocturnal resting sites may be a considerable distance from feeding areas, and distribution of the species is generally correlated with grassbed distribution, location of resting beaches, and possibly ocean currents (Hirth 1971).

Immediately after hatching, green turtles swim past the surf and other shoreline obstructions, primarily at depths of 20 centimeters or less below the water surface, and are

dispersed both by vigorous swimming and surface currents (Frick 1976; Balzas 1980). The whereabouts of hatchlings to juvenile size (35 centimeters) is uncertain. In the Hawaiian Archipelago, juveniles greater than 35 centimeters in length, as well as subadults, feed and rest in shallower coastal areas than adults. Hawaiian adult and immature turtles come inshore at certain undisturbed sites to bask or rest (Balzas 1980). Green turtles tracked in Texas waters spent more time on the surface, with fewer submergences at night than during the day, and a very small percentage of the time was spent in the Federally maintained navigation channels. The tracked turtles tended to utilize jetties, particularly outside of them, for foraging habitat (Renaud et. al. 1993). Estimates of age at sexual maturity range from 20 to 50 years (Balazs 1982; Frazer and Ehrhart 1985) and they may live over 100 years Zug et al. (1986).

Most green turtle populations have been depleted or endangered as a result of direct exploitation or incidental drowning in trawl nets (King 1981). Defunct green turtle fisheries in Louisiana and Texas indicate it was more common in areas where it is now rare (Rebel 1974, in Fritts et al. 1983). In Texas in the 1800's, the green turtle fishery was the first to appear and disappear. Animals were captured from April to November, primarily when they were returning to diurnal feeding areas from nocturnal resting places in deeper waters of bays (Hildebrand 1981). Green turtles in Texas still inhabit the same seagrass meadows as at the turn of the century, although in reduced numbers (Hildebrand 1981). In Florida, the nesting population was nearly extirpated within 100 years of the initiation of commercial exploitation (King 1981).

Population decline has been attributed to heavy fishing pressure and human nest predation (Dundee and Rossman 1989) and not activities associated with MM. Historically, green turtles were fished off the Louisiana coast (Rebel 1974); exploitation and incidental drowning in shrimp trawls has contributed to the decline of this species and its eventual listing (King 198 1).

Although there is the possibility of incidental interaction with permitted MM activities, due to the lack of extensive seagrass beds and the low incidence of sightings and strandings, impacts to the green sea turtle population are not expected.

HAWKSBILL SEA TURTLE (Eretmochelys imbricata)

The hawksbill was listed as an endangered species in June 1970 (U.S. Fish and Wildlife Service 1991a) and its current

status in Louisiana is unknown (U.S. Fish and Wildlife Service 1990). Only one record of a hawksbill in Louisiana has been reported (Fuller and Tappen 1986). One specimen was reported from a gillnet catch in Cameron Parish, Louisiana, in the 1986 survey of Louisiana coastal waters by the National Marine Fisheries Survey (Fuller et al. 1987). This supports the general belief that hawksbills are scarce in Louisiana waters. The stranding network data from 1990 through 1994 reported only one hawksbill stranding in Louisiana. Impacts to hawksbill populations from HM activities are likely to be negligible due to its rarity along the Louisiana coast.

The hawksbill sea turtle is the second smallest sea turtle being somewhat larger than the Kemp's ridley. Nesting females average about 87 cm in curved carapace length (Eckert 1992). The adults are easily recognized by their thick carapace scutes, usually with radiating brown and black streaks on an amber background, and a jagged posterior margin on the carapace. The name of the turtle is derived from the tapered beak and narrow head.

These turtles generally live most of their life in tropical waters such as the warmer parts of the Atlantic Ocean, Gulf of Mexico and the Caribbean Sea (Carr 1952 and Witzell 1983). Florida and Texas are the only states where hawksbills are sighted with any regularity (NMFS and USFWS 1993).

Hawksbills nest throughout their range, but most of the nesting occurs on restricted beaches, to which they return each time they nest. The hawksbill breeds and nests in warm waters between 25° North and 25° South latitude (Rebel 1974). These turtles are some of the most solitary nesters of all the sea turtles. Depending on location, nesting may occur from April through November (Fuller et al. 1987). These turtles prefer to nest on clean beaches with greater oceanic exposure than those preferred by green sea turtles, although they are often found together on the same beach. The nesting sites are usually on beaches of fine gravelly textures. Hawksbills have been found in a variety of beach habitats ranging from pocket beaches only several yards wide formed between rock crevices to a low-energy sand beach with woody vegetation near the waterline. These turtles tend to use nesting sites where vegetation is close to the waters edge.

Mating takes place offshore near the nesting sites. Males rarely come ashore. Mature females come to shore at night to prepare nests at the upper part of the beach. Females nest several times a season and have up to 200 eggs per clutch (NMFS and USFWS 1993). Each female may not reproduce

every year. Young turtles dig out of nests and go to sea in search of food. Large numbers of young are normally lost to predation. Since the juvenile mortality rate is high, rapid growth and adult longevity tend to make most turtle populations consist of mainly larger turtles.

Juvenile hawksbills are normally found in waters less than 15 meters in depth. Areas around coral reefs, shoals, lagoons, lagoon channels and bays with marine vegetation that provides both protection and plant and animal food. The hawksbill can tolerate muddy bottoms with sparse vegetation unlike the green turtles.

This species is an omnivore, feeding primarily on invertebrates and marine vegetation (Dundee and Rossman 1989). The hawksbill was once thought to be a generalist or opportunistic feeder but studies now indicate that the primary food source is comprised of sponges and other encrusting organisms. Other organisms found in the diet are now believed to be incidental organisms living in association with the sponges which are being used for food (Meylan 1988). Adults forage around reefs up to 100 meters in depth and are not usually in shallow waters less than 20 meters in depth. Juveniles forage in shallow waters near the shallowest coral reefs. Offshore behavior of the turtles is not well understood. Both single and mated pairs of adult turtles and juveniles as well have been observed in all seasons in the Caribbean. It is thought they are foraging on the live bottom sponges in the area.

The hawksbill is probably a diurnal species and only feeds in daylight in captivity. These turtles go through a pelagic feeding phase as hatchlings and are normally associated with seaweed mats. During this phase the juveniles feed on the shallow reefs until they reach a length of 15-25 centimeters. As the turtles mature they move from pelagic feeders to benthic feeders. With this change in feeding habits the foraging territory is moved further and further from shore to the deeper waters as the turtle improves its capability for deep dives.

LEATHERBACK SEA TURTLE (<u>Dermochelys coriacea</u>)

The leatherback sea turtle was listed as an endangered species in June 1970 (U.S. Fish and Wildlife Service 1991a). Population decline of this turtle has been attributed to exploitation of eggs and juveniles (Ross 1981) and not activities associated with HM. Due to the low incidence of sightings and strandings along the Louisiana coast, there is little possibility that permitted HM activities will adversely affect leatherback sea turtle populations.

The leatherback sea turtle occurs mostly in continental shelf waters and exhibits seasonal fluctuations to the Gulf Stream and other warm water features (Fritts et al. 1983a, Hirth 1980, Pritchard 1971). Nesting leatherbacks occur along beaches in Florida (USA), Nicaragua, and islands of the West Indies, however no nesting has been reported in Louisiana (Gunter 1981, Dundee and Rossman 1989). Leatherbacks have been collected or sighted in Louisiana from Cameron Parish, Atchafalaya Bay, Timbalier Bay, and Chandeleur Sound (Dundee and Rossman 1989). These turtles feed primarily on jellyfish and other cnidarians. These turtles have been associated with large schools of cabbage head jellyfish (Stomolophus meleagris). Ingestion of marine plastic, apparently being mistaken for food, has been reported by Fritts et al. (1983a).

Historical sightings of leatherback turtles have been reported in Louisiana from Terrebonne Bay and Timbalier Bay. Sightings were noted by helicopter pilots in National Marine Fisheries Service statistical zones 12, 14 and 17 in January, March, and April (Fuller 1986). These zones include the area off Isles Dernieres and Timbalier Islands (Area 14) and off Cameron (Area 17). Leatherback turtles have been reported in aerial surveys off Marsh Island in April. They were observed in waters of a depth of 20 meters and 330 meters, approximately 55 and 190 kilometers from shore, respectively (Fritts et al. 1983). Low numbers of leatherback turtles reported by fishermen in coastal Louisiana may reflect low numbers in the area, or lack of fishing in areas where the species could occur (Fuller 1986). Only eight leatherbacks were stranded on Louisiana beaches from 1990 through 1994.

SOUTHERN BALD EAGLE (Haliaeetus leucocephalus)

The bald eagle was listed as an endangered species in March 1967 (U.S. Fish and Wildlife Service 1991a); since that time, these birds have increased in number in Louisiana (U.S. Fish and Wildlife Service 1991b). The southern bald eagle, which breeds in Louisiana, is a subspecies of the bald eagle (Haliaeetus leucocephalus). Forty-two active nests, producing 53 fledglings, were reported for the 1990-91 breeding season in Louisiana. A steady increase in the number of active nests has occurred over the past 20 years. Only five active nests and four fledglings were reported for the 1973-74 season in Louisiana (U.S. Fish and Wildlife Service 1991b).

Bald eagles suffered a pronounced population decline between the late 1940's and the 1970's, largely due to reproductive failure caused by pesticide accumulation in their food chain

(Lowery 1974a). Other factors negatively affecting the bald eagle population include electrocution, severe weather, forested habitat loss, human persecution and disturbance, and lead poisoning. Decline has not been associated with HM activities.

Marsh management activities may have an impact on nesting bald eagles. Projects that destroy nest trees or create conditions that would cause birds to abandon nesting efforts would impact this species. Coordination that is typically taken to avoid human persecution will reduce potential impacts to this species. Activities that convert open water foraging areas to emergent marsh would reduce the availability of these areas for foraging by eagles.

Dugoni (1975), found that eagles breeding in forested wetlands just north of the coastal marshes in Louisiana, do not prefer nesting territories based on surrounding habitat availability alone. Usually a clear flight path to water, a good perching tree, and open view of the surrounding area are factors involved in nest site selection. Nesting densities of bald eagles have been correlated with adequate prey availability and water body size and productivity. Large shallow open water areas with relatively high rates of fish production are normally located within nesting habitat. A typical nest site would be located in second growth baldcypress-tupelogum swamp with marshes, canals, and water bodies nearby (Dugoni 1980). The bulky stick nests constructed by these birds are usually located in a stand of trees near water and tend to be found just below the crown of the largest living tree in the stand.
Bald eagles in Louisiana generally lay two to three eggs during mid-winter (November/December), while the young hatch during the months of January or February. The young fledged from the nest three months later. The characteristic white head and tail feathers are not obtained until the birds are approximately four to five years of age.

Although the bald eagle is an opportunistic feeder, its primary food source is comprised of fish in shallow water areas (Haywood and Ohmart 1986). Carrion is another common component of the diet of these birds (Lowery 1974a). Dominant prey items included freshwater catfish and American coots.

PIPING PLOVER (*Charadrius melodus*)

The piping plover was listed as an endangered and threatened species in December 1985 (U.S. Fish and Wildlife Service 1991a); these birds have continued to decline in Louisiana (U.S. Fish and Wildlife Service 1990). The population of

piping plovers which winters on the Gulf of Mexico coast, the same population which nests in the Great Lakes and Northern Great Plains region, is comprised of approximately 1400 pairs (Melvin et al. 1991). The amount of time these birds spend on their nesting grounds is less than one third of the year (U.S. Fish and Wildlife Service 1988).

Lowery (1974a) observed that in Louisiana, piping plovers were commonly seen between early March and late April during spring migration and from early August and early October during fall migration. This species was noted as uncommon in Louisiana during the remaining portions of the year. Sightings of piping plovers on the eastern portion of Isle Denieres and Timbalier Island have been documented by Nicholls (1989). Unpublished winter survey data from Richard Martin (Louisiana Department of Wildlife and Fisheries) indicate that the Chandeleur Islands, Timbalier Islands, Isles Demieres, Atchafalaya Delta, and Fourchon Beach are important as wintering sites for piping plovers in Louisiana. These barrier island locations are usually not associated with HM activities.

Hunting of piping plovers in the early 1900's and the destruction of historical nesting sites, have resulted in a dramatic decline in this species' population (U.S. Fish and Wildlife Service 1988). A further detrimental impact to the population is attributed to the reduction of wintering habitat along the Gulf Coast, largely due to recreational and commercial development and dune stabilization (Haig 1985; U.S. Fish and Wildlife Service 1988). Recreational activities in localized areas along the Gulf Coast have been correlated with a decrease in piping plover use of those areas (Nicholls 1989), while dune stabilization projects which result in steep beach slopes, narrow beach widths, or increased vegetation reduce plover habitat (Haig 1985). Additionally, urbanization has led to an increase in predation on the piping plover population (U.S. Fish and Wildlife Service 1988).

The piping plover diet consists mainly of invertebrates. These birds forage predominantly in intertidal areas having a substrate composed primarily of sand (Nicholls 1989). Ideal wintering habitat for piping plovers on the Gulf Coast would contain large sand flats or sandy mud flats adjacent to a tidal pass or tidal inlets (Haig 1985; Nicholls 1989). A thin layer of mud covering the sand appears to attract plovers, due possibly to food or refuge association. Barrier beaches with overwash areas or sections of old marshes also attract plovers. (Nicholls 1989). A gulf-facing beach with a very low gradient, thus an increased intertidal zone, offers an almost equally attractive area (Haig 1985; Nicholls 1989). Preferred sites

have a dry sandy area above the wrack line which is used for roosting and are large in size, with little or no human activity; although, piping plovers will occupy habitat that is less than optimal when optimal sites are not available (Nicholls 1989). The quality or quantity of winter habitat may be a factor limiting recovery of the species (U.S. Fish and Wildlife Service 1987c). In Texas, there has been a loss of approximately 30% of the piping plover wintering habitat over the past 20 years (U.S. Fish and Wildlife Service 1985). With continued erosion of Louisiana's coastline, further reductions in piping plover wintering habitat are anticipated.

BROWN PELICAN (Pelecanus occidentalis)

The brown pelican was listed as an endangered species in October 1970 (U.S. Fish and Wildlife Service 1991a); since that time, these birds have increased in Louisiana (U.S. Fish and Wildlife Service 1990). Brown pelicans were historically abundant across the entire Louisiana coastal region. Population estimates between 1918 and 1933 ranged from 12,000 to 85,000 birds (King et al. 1977). Nesting occurred on Isles Demieres, East Timbalier Island, the mud lumps in the Mississippi Delta, Grand Gosier Island, the Chandeleur Chain, North Island adjacent to the chain, and Isle au Pitre (Lowery 1974a). However, a sharp decline in nesting was observed between 1958 and 1961. By 1962, no brown pelicans were found nesting in the state and by the mid-1960's, brown pelicans had been extirpated from Louisiana (Lowery 1974a; McNease et al. 1984). This sudden and dramatic decline may have been attributable to pesticide poisoning which caused reproductive failure and a direct die-off of adults (Lowery 1974a, King et al. 1977, Blus et al. 1979).

Between 1968 and 1980, the Louisiana Department of Wildlife and Fisheries and the Florida Game and Freshwater Fish Commission released 1,276 brown pelicans from Florida into coastal Louisiana (McNease et al. 1984). A subsequent die-off of pelicans occurred in 1975, resulting in a 40% decline in the new Louisiana population to 250 birds. This die-off was associated with the presence of endrin within the pelican food chain and its direct toxicity to the birds (Blus et al. 1979) and not HM related activities. Since that time, the numbers of brown pelicans in Louisiana have increased. Martin and Lester (1991) reported six breeding colonies in the state in 1990, representing a total of 2,196 adults. Colonies ranged in size from 1500 adults on North Island in the Chandeleur Island chain to 15 adults on East Timbalier Island. Other colonies were located on Queen Bess Island, Grand Gosier Island in the Chandeleur Island. chain,

Isles Demieres, and on the mud lumps in South Pass.

Nesting in Louisiana commences in mid-winter (Lowery 1974a). These birds generally wander along the Gulf Coast during winter months, but often remain in the vicinity of their breeding colonies (Bent 1922). Brown pelicans feed predominately in coastal waters but will feed up to 20 miles offshore (Hingtgen et al. 1985). Their diet consists entirely of fish (Lowery 1974a), primarily menhaden and mullet (Bent 1922), which have been shown to be affected by HM activities (Herke et al. 1992, Rogers et al. 1992a, Rogers et al. 1992b).

Construction of HM activities near resident brown pelican populations can be restricted to preclude any direct adverse impacts to the population. Based on available data, operation of HM projects have no direct significant impacts on brown pelicans. However, because migratory estuarine fish are important in the diet of brown pelicans, some HM activities may indirectly impact on foraging locations and success, and on the reproductive potential of the species. Intensive HM with structures regulating the hydrological regime of an area, may seasonally diminish the abundance of some brown pelican prey species, and intensify inter- and intra-specific competition for resources in adjacent unmanaged marsh locations.

ARCTIC PEREGRINE FALCON (Falco peregrinus tundrius)

The Arctic peregrine falcon was listed as an endangered species in October 1970 (U.S. Fish and Wildlife Service 1991a). Since that time, its status has been upgraded to threatened; these birds have increased in number in Louisiana (U.S. Fish and Wildlife Service 1990). The Arctic peregrine falcon is a highly migratory subspecies of the peregrine falcon *(Falco peregrinus), and* winters along the western coast of the Gulf of Mexico and the Atlantic coast of Central and South America. Peregrine falcons can be found along the Louisiana coast from early September to mid-May (Lowery 1974a). During the summer these falcons migrate north to their nesting grounds in the northern tundra regions of Alaska, Canada, and Greenland (U.S. Fish and Wildlife Service 1982).

During the early portion of this century, the peregrine falcon population remained relatively stable despite persecution and the loss of prime wetland habitat. However, heavy use of chlorinated hydrocarbon pesticides in the late 1950's and early 1960's caused the thinning of egg shells of nesting peregrine falcons, resulting in wide-spread reproductive failure. This caused a dramatic population

decline for the species (Lowery 1974a). Marsh management activities have not been implicated as a factor in population decline of peregrine falcons.

The diet of these birds is comprised exclusively of avian prey. Habitat needs for wintering and migrating peregrine falcons are essentially the same: adequate roosting habitat and a supply of avian prey. Various elevated structures ar-e used for roosting where the falcon can rem ' relatively undisturbed (U.S. Fish and Wildlife Service 1982). 'ne avian prey source consists of a wide variety of species, but the majority of the prey is comprised of shorebirds, waterfowl, doves, and pigeons. Shorebirds and waterfowl provide the majority of prey species on the coastal wintering grounds (Lowery 1974a), whose populations respond favorably through HM activities.

It is believed that the concentration of over-wintering prey species, especially shorebirds and waterfowl, attracts peregrine falcons to coastal Louisiana (U.S. Fish and Wildlife Service 1987a). The flat terrain and low vegetation of the Gulf Coast offers hunting conditions similar to the Arctic tundra, which allows these birds to spot and pursue their prey with ease (Hunt et al. 1975). Although no critical wintering habitat areas in the United States have been defined, the Louisiana Gulf Coast has been noted as a major wintering area and as a staging area for further migration.

LOUISIANA BLACK BEAR (Ursus americanus luteolus)

The Louisiana black bear was listed as a threatened species in February 1992 (U.S. Fish and Wildlife Service 1992). A subspecies of the American black bear (Ursus americanus), the Louisiana black bear historically ranged throughout Louisiana, southern Mississippi, and eastern Texas. Present populations exist in the Atchafalaya and Tensas River basins of Louisiana and southwestern Mississippi (Hammond 1989). Currently, a small population of Louisiana black bear exists in southern St. Mary and Iberia Parishes, Louisiana (Hammond 1989, Pace 1992). Cause for decline has been attributed to past and potential habitat losses, the vulnerability to human persecution, and illegal killing (U.S. Fish and Wildlife Service 1992). Decline has not been associated with HM activities.

Louisiana black bears utilize a variety of mostly terrestrial habitats including marsh, forest, and agricultural areas, and require large areas of relatively undisturbed bottomland habitat (Weaver et al. 1990, Pace 1992), in areas usually not associated with HM projects.

Activity centers around foraging, search for cover, and breeding. Typically, males have larger home ranges than females and ranges may increase during the summer and fa.U for both sexes in response to food availability and search for mates. Mating generally occurs in the summer months which is the only time adult males and females are in contact with one another.

Bears utilize a variety of foods including hard mast, soft mast, and invertebrates (Weaver et al. 1990). Early successional habitats (agricultural areas, cane thickets, clear cuts) seem to be important for feeding during the spring and summer (Weaver et al. 1990), as these areas provide diversified sites for annual and perennial vegetative growth. Mid-to-late successional forest habitat is important during the fall for bears as these areas contribute hard mast which is heavily used in preparation for winter. Diet exhibits a seasonal shift from succulent, herbaceous growth in the spring, to soft mast in the summer, to hard mast in the fall (Hellgren and Vaughan 1988, Weaver et al. 1990). In preparation of winter, bears exhibit their most rapid weight gain during the fall. Animal foods supplement plant foods during all seasons (Hellgren and Vaughan 1988, Weaver et al. 1990).

Activity and movements generally decline from November through January as bears den in response to food scarcity and winter weather. Bears may utilize ground dens in thick understory areas of switchcane, palmetto, and logging slash, or select trees with suitable cavities (Weaver et al. 1990). Cubs are born in the winter den during January and February and remain with the female for fifteen to twenty months.

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Zwinenberg, A.J. 1977. Kemp's ridley, Lepidochelys kempi

(Garman 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of _Lepidochelys olivacea_). Bull. Maryland Herp. Soc. 13:170-192.

H - Socioeconomics

1. INTRODUCTION

1.1. This appendix has been developed for use as a template, outlining the socioeconomic parameters and relationships pertaining to the hydrologic management (HM) permits described in this EIS. The appendix briefly describes the potential significance of these parameters with respect to existing and future HM projects permitted by the Corps of Engineers. It provides an inventory of existing conditions. This appendix considers cumulative effects only to the degree that it identifies issues which should be considered when evaluating the social and economic effects of HM (HM) projects, and to the degree that decisions regarding one project might bear on others.

1.2. The primary stated functions of HM projects are to modify salinity levels, sediment losses, flow velocity, and water levels, and to regulate tidal flows. The purposes and needs of HM projects permitted by the Corps of Engineers since the late 1970's have been defined as plans to maintain and/or enhance fish and wildlife resources, to develop additional fish and wildlife research, to restore the quality of the marshes, or to develop some combination of these activities. A small number of HM permits have also been issued as aquaculture projects (marine fish and shellfish farming) but will not be addressed in this report.

1.3 General regulations for evaluating the socioeconomic implications of such broadly defined purposes have been developed in response to the National Environmental Policy Act of 1969 (NEPA); the River and Harbor and Flood Control Act of 1970 (Section 122); the Federal Water Pollution Control Act of 1972 as amended (Clean Water Act); and a wide range of Congressional legislation, Executive Orders, and other agency regulations, requiring compliance with NEPA guidelines.

1.4. Section 2 of this Appendix briefly describes the socioeconomic resources in the hydrologic basins where HM occurs. Section 3 describes the existing condition of significant socioeconomic resources and the effects of 1) continued maintenance of existing permits and denial of all future permits for HM; and, 2) immediate installation, operation and maintenance of all the HM projects described in the Louisiana Coastal Wetlands Restoration Plan developed under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA).

2. GENERAL SOCIOECONOMIC DESCRIPTION OF HYDROLOGIC BASINS

2.1. This section provides brief outlines of socioeconomic characteristics in the basins where HM projects have been

built and where additional projects are anticipated as part of CWPPRA.

2.2. Pontchartrain Basin. Portions of nine parishes lie within the basin, including Ascension and Livingston Parishes which are part of the Baton Rouge Metropolitan Statistical Area (MSA), and St. James, St. John the Baptist, St. Charles, Jefferson, St. Bernard, and Orleans Parishes which are all part of the New Orleans MSA. The total area considered part of the basin covers some 1,700,000 acres; however, three large lakes, Maurepas, Pontchartrain, and Borgne cover 55 percent of the basin. Marsh makes up nearly 268,000 acres of this basin. The geographical limits of the basin are the prairie terrace on the north, the Mississippi River and the Mississippi River Gulf Outlet (MRGO) on the west and south and Chandeleur Sound on the east. The social and economic conditions on the east bank of the Mississippi are significantly influenced by conditions on the west bank of the river, particularly in the New Orleans area since both banks are part of the urbanized area. The 1990 census of population in the entire 9-parish area was 1,244,900. Economic developments center around oil and gas production and processing; tourism; waterborne commerce and other port-related construction, maintenance, and commerce; along with other sales, services, and financial activities normally associated with large metropolitan areas. The commercial harvest of fish and wildlife, and the sale and service of boats and supplies for both commercial and recreational purposes, are also important to the regional economy. The completion of construction activities generated by the expansion of oil and gas production during the 1960's and 1970's, and the subsequent decline of oil prices and production during the 1980's, have been major factors influencing limited economic growth, high unemployment rates, and out migration in the area.

2.3. Breton Sound Basin. The basin includes portions of Plaquemines and St. Bernard Parishes. Only a small portion of the urbanized section of the New Orleans MSA along the southern boundary of St. Bernard Parish is included in the basin. Breton Sound Basin encompasses approximately 676,400 acres, of which 184,100 acres are wetlands. It is bounded on the west by the Mississippi River, on the north by Bayou La Loutre, on the east by the Mississippi River Gulf Outlet, and on the south by Baptiste Collette Bayou and Breton Islands. The basin had a 1990 population of 9,268. The comparatively small population is due to the limited amount of land which is not subject to tidal overflows, flooding, and periodic hurricanes. In addition to commercial fishing, employment opportunities include support activities and mineral production, primarily oil and gas.

2.4. Barataria Basin. The basin contains approximately 1,565,00 acres, with portions located in nine parishes, including Assumption, Ascension, St. James, Lafourche, St. John the Baptist, St. Charles, Jefferson, Plaquemines, and Orleans. The basin drains southward from a point near Donaldsonville, Louisiana between the east bank of Bayou Lafourche and the west bank of the Mississippi River, to a chain of islands which separates the basin from the Gulf of Mexico. The southern half of the basin consists of tidally influenced marshes connected to a large bay system behind the barrier islands. The basin contains 152,120 acres of swamp, and 468,680 acres of marsh. As indicated in paragraph 2.2.1., a number of the parishes which form at least portion of the basin are part of the New Orleans MSA. The total population of the nine parishes is about 1,241,000. The basin also includes part of Lafourche Parish which is one of the parishes making up the Houma MSA (the City of Houma is in the Terrebonne Basin). Economic developments center around oil and gas production and processing; tourism; waterborne commerce and port-related construction, maintenance, and commerce; along with other sales and services normally associated with large metropolitan areas. The commercial harvest of fish and wildlife, and the sale and service of boats and supplies for both commercial and recreational purposes, are also important to the basin's economy.

2.5. Terrebonne Basin. The Terrebonne Basin includes all of Terrebonne Parish and parts of Lafourche, Ascension, and Assumption Parishes, and small portions of St. Martin and St. Mary Parishes. The 1,712,500 acre basin is bounded by the Mississippi River on the north, by Bayou Lafourche on the east, by the Atchafalaya Basin on the west, and by the Timbalier/Dernieres barrier island chain on the south. The basin includes about 155,000 acres of swamp, and almost 574,000 acres of marsh. As discussed in the previous paragraph, Terrebonne Parish is part of the Houma MSA. This metropolitan area has experienced the benefits and the difficulties of fluctuations in the oil and gas industries, including declines in employment, income opportunities and population growth during the 1980's. In 1990 the total population of Terrebonne, Lafourche, Ascension, St. Mary, and Assumption Parishes was about 321,900. Major sources of income and employment have been oil and gas exploration and production, related construction, transportation, and services, and wholesale, retail, and commercial services generated by the production industries. Agricultural production of sugarcane, soybeans, grains, and livestock and livestock product is important in the higher elevations of the basin.

2.6. Teche/Vermilion Basin. The Teche/Vermilion Basin

contains roughly 382,000 acres of which nearly 243,000 acres are wetlands in Vermilion, Iberia, and St. Mary Parishes. The basin is bordered on the east by the Atchafalaya Basin, on the west by Freshwater Bayou Canal and La. Highway 82, on the north by the Lafayette/Vermilion and St. Martin/Iberia Parish lines and on the south by the Gulf of Mexico. The parishes which are part of the basin had a 1990 population of 176,438. The production of natural gas and petroleum and related supplies and services are major sources of employment and income in the basin. The production of rice, sugarcane, livestock, and livestock products, are also important to the local economy.

2.7. Mermentau Basin. The Mermentau Basin lies in the eastern portion of the Chenier Plain in portions of Cameron and Vermilion Parishes. The 734,000 acre basin is bound on the east by Freshwater Bayou Canal, on the west by Louisiana State Highway 27, on the north by the coastal prairie ridge, and on the south by the Gulf of Mexico. The basin contains about 450,000 acres of wetlands. The total population of Cameron and Vermilion Parishes in 1990 was about 59,300. Similar to the other coastal basins, the Mermentau Basin has been an important source of natural gas and petroleum; their benefits to the local and regional economies have declined in recent years as development has been either completed or become costly due to foreign competition. Somewhat like Plaquemines Parish on the eastern end of the State, Cameron Parish is largely wetlands and subject to severe weather conditions; therefore, the potential for population growth is limited in spite of access to abundant natural resources, including oil, gas, and fish and wildlife resources.

2.8. Calcasieu/Sabine Basin. The Calcasieu/Sabine Basin is located in portions of Cameron and Calcasieu Parishes. It is bounded by Louisiana Highway 27 on the east, by the Sabine River on the west, by the Gulf Intracoastal Waterway on the north and by the Gulf of Mexico on the south. It consists of approximately 630,000 acres about half of which is wetlands (312,500 acres). Calcasieu Parish is coextensive with the Lake Charles MSA. While the population of Cameron Parish is only about 9,260, the population of Calcasieu Parish is about 168,100. The economy of the Lake Charles MSA is based on both oil and gas processing, production, and transportation, and regional market trends like other metropolitan areas. The Calcasieu River and Pass waterway provides the city and port of Lake Charles with a 36-foot channel.

I - Prime and Unique Farmlands

NOTE: This Appendix was prepared by the USDA-NRCS

The prime farmland designation reflects a current or potential land use. In Louisiana's coastal parishes, prime farmlands are comprised largely of the soils and areas that comprise distributary ridges (e.g., Bayou Lafourche, cheniers).

There are 1,051,900 acres of prime farmland located in the 13 coastal parishes (Table K1). Vermilion Parish has the largest acreage (275,000) while St. Bernard (18,400) has the smallest acreage.

Some areas designated a prime farmland may be comprised of hydric soils. As such, some prime farmland areas may be wetland areas or exhibit some wetland attributes.

There is little likelihood that prime farmlands would be impacted by MM activities because the kinds of wetlands that are the subject of the PMMEIS are not the kinds that would be typically classified as prime farmlands. Nonetheless, some MM efforts are designed to affect the quantity and quality of the vegetated surface and control water levels. Such management may elevate the grazing potential of the managed area. By moving cattle grazing operations to managed marshes, prime farmlands formerly dedicated to grazing become available for alternative agricultural uses.

The actual relationship between a specific MM plan and prime and unique farmlands is characterized and evaluated as part of each and every analysis of requested permits performed by the NOD in conjunction with MM.

J - Cultural Appendix

FILE/PROGRAMA

DRAFT
SEVERAL SECTIONS TO BE COMPLETED

CELMN-PD-RN (1165-2-26a) 29 May 95

MEMORANDUM FOR: CELMN-PD-RS

SUBJECT: Input for Marsh Management Programmatic EIS

Enclosed please find the preliminary information on Cultural Resources for the above referenced project.

PRESENT COASTAL ZONE CONDITIONS

Cultural Resources
The coastal wetlands of Louisiana are known to contain numerous historic and prehistoric archeological sites. These sites span the human occupation sequence of the state and represent Louisiana's long cultural heritage. Over twenty four hundred archeological and historical sites have been recorded for the ten identified Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) river basins. In addition to these sites, more than two hundred historic properties are listed on the National Register of Historic Places.

The prehistoric sites in the area are predominantly Indian shell middens situated along the natural levees of rivers and bayous and surrounding shorelines of the numerous coastal lakes. Archeological evidence indicates that these prehistoric Indians gathered both freshwater and brackish water shell fish available in the nearby waters. These sites were habitation areas as well as camp sites for shellfish processing. Numerous mound sites also exist on the higher ground in the coastal zone. Salt domes and cheniers are another favorite habitation area...

Historic sites in the coastal area date as far back as colonial times. These sites are usually located along the natural levees of bayous and rivers. These waterways served as transportation routes in the past and continue to be used for commerce even now. Types of historic sites include domestic buildings, boat landings, hunting and fishing camps, farms, plantations, commercial and industrial sites as well as shipwrecks, military fortifications and so forth.

<MORE DETAIL ON TYPES OF SITES AND OCCUPATIONAL SEQUENCES>

Many of these archeological sites and historic properties have been determined eligible to or listed on the National Register of Historic Places. The National Register of Historic Places was

established in 1966 by the National Historic Preservation Act (NHPA). The National Register is used as a key management tool for cultural resource management. National Register criteria for significance is used to examine all cultural resources in determining if a site is significant or not significant. All federal agencies having direct or indirect jurisdiction over federal, or federally assisted, permitted, or licensed activities have to take into account the effects of the proposed undertaking on cultural resources.

The National Historic Preservation Act of 1966 (NHPA) as amended was enacted to ensure that the country's historic resources would be considered in any federal project and federally assisted or permitted projects. Section 106 of this act states that all federal agencies "take into account" how their proposed actions would affect any historic or archeological property. A federal undertaking includes a wide variety of actions such as construction activities, rehabilitation and repair projects, permits, and demolition to name a few. Federal agencies are required to consider alternatives to avoid, mitigate, or minimize adverse impacts on historic properties (any prehistoric or historic district, site, building, structure, or object eligible for inclusion in the National Register). The federal agency involved in the proposed project is responsible for initiating and completing the Section 106 review process. The federal agency confers with the State Historic Preservation Officer (an official appointed in each state to administer the National Historic Preservation Program) and the National Advisory Council on Historic Preservation.

There are five basic steps in the Section 106 review process. These are:

1. Identify and Evaluate Properties;
2. Assess Effects;
3. Consultation;
4. Council Comment; and
5. Proceed

Step 1 <u>Identify and Evaluate Properties.</u> The lead federal agency is responsible for reviewing all available documents, maps and cultural resource databases to determine the level of cultural resource survey coverage as well as the presence or absence of prehistoric and/or historic resources in a project area. If survey coverage is non-existent or additional information is needed, the federal agency may conduct additional work. All cultural resources located in a project area are then evaluated for significance using National Register of Historic Places (NRHP) criteria. The federal agency and the State Historic Preservation Officer decide whether the properties are eligible for listing to the National Register.

Step 2 <u>Assess Effects.</u> Following identification and evaluation of cultural resources, the federal agency is responsible for determining the effect of its proposed action/activity on significant cultural resources. This determination of effect is

made in consultation with the State Historic Preservation Officer (SHPO).

There are three possible determinations:
a. No effect. This determination is made when the agency's proposed action will have no effect on cultural resources in the project area. The agency notifies the SHPO. If the SHPO does not object, the project may proceed.

b. No adverse effect. In this case there could be an effect to a cultural resource, but the effect is not harmful. The agency obtains SHPO concurrence and submits to the Advisory Council a determination of no adverse effect. The project may proceed.

c. Adverse effect. This is when it has been determined that the proposed action could have a harmful effect on a cultural resource. The agency is required to begin the consultation process.

Step 3. Consultation. The purpose of consultation is to find acceptable ways to reduce the harm to a cultural resource so the project may proceed. This may involve such measures as avoiding the cultural resource or mitigating the adverse effect. The federal agency and the SHPO are the consulting parties. The Council determines their level of involvement in this step. When the consulting parties agree upon steps to avoid or mitigate harm they sign a Memorandum of Agreement (MOA). If an agreement cannot be reached, the federal agency may submit documentation to the Advisory Council for comments.

Step 4. Council Comment. After consultation, the federal agency submits the signed MOA to the Council for review. The Advisory Council has the option to sign the MOA, request changes or chose to issue written comments on the proposed activity. If an agreement was not reached in consultation by the SHPO and the agency, the council will submit written comments to the agency regarding the proposed action.

Step 5 Proceed. If agreement was reached and a MOA was signed then the agency can proceed with the project. If an MOA was not signed then the Federal Agency must take into account the Council's written comments.

Each year numerous project permit requests are submitted to the Regulatory Division of the U.S. Army Corps of Engineers. The New Orleans District recognizes its responsibility regarding cultural resources management and the Section 106 process of the National Historic Preservation Act. All COE permit requests are mailed to the State Historic Preservation Office. If the Environmental Review Coordinator in the Louisiana State Historic Preservation Office feels that a survey is necessary or some other action must be taken, than a letter is sent with the review results.

The Natural\ Cultural Resources Section of the U.S. Army Corps of Engineers, New Orleans District has been coordinating with the State Historic Preservation Office regarding cultural resources investigations associated with various projects and Section 106 requirements.The Section 106 process can sometimes be very lengthy and complicated.

The New Orleans District has surveyed project lands for cultural resources for over twenty years now. The surveys were conducted prior to construction of main line levees, hurricane protection levees, dredging, erosion control programs, Coastal Wetlands Planning, Protection and Restoration Act projects. These surveys have produced large quantaties of data about archaeological/ historical sites including site maps, reports, artifact catalogs and so forth.

Archaeological Resources in the Coastal Zone has been entered into the the Cultural/Natural Resources Analysis Section computerized working database program known as the Cultural Resources Information System (CRIS). Under an agreement with the State Historic Preservation Office, Division of Archaeology their archaeoloical site file data was entered into a Dbase 3 format in 19--. This computerized database is now being updated.

CULTURAL RESOURCES INCLUDING NATIONAL REGISTER SITES

Various marsh management projects may or may not have an adverse impact on cultural resources. Each proposed project action must be examined on a project by project basis. Cultural resources evaluations are made on site specific as well as project specific information and plans. Maps indicating the location of cultural resources and cultural resources survey coverage are checked against the location of the proposed marsh management projects.

Several cultural resources investigations have been conducted in the coastal zone which have identified numerous archeological and historical sites. These surveys, however, only cover a small percentage of the coastal zone. Many more surveys need to be conducted to determine the presence or absence of significant cultural resources.

A cultural resources evaluation of each of the proposed marsh management projects will need to be conducted as soon as an permit application is received in order to avoid project delays. In some cases project designs could destroy, damage, or obscure archeological sites by construction activities. Cultural resource investigations will identify any significant cultural resources which may be at risk and allow time for changes to the project designs to avoid adverse impacts. The site specific nature of these resources demand this type of action. In some instances the proposed action may actually help to preserve and protect cultural resources. Coastal lands are eroding rapidly and the protection of these lands by the various marsh management projects may protect

sites in the long run by stopping or slowing down land erosion.

Three major types of actions predominate these proposed erosion measures. These are: 1.) sediment diversion or re-deposition, 2.) dredging of some type, and 3.) building of structures. Sediment diversion may or may not have an adverse impact on historical or archeological sites. Increased sediment flow may cause a direct impact on any site in the immediate area, while in some cases it could provide sediment around an area acting as a buffer to further erosion. Depositing sediment on top of a known site can change the environment in which a site has survived. This may or may not be an adverse impact. Dredging a waterway could impact any prehistoric or historic shipwreck in the area. Submerged cultural resources surveys are conducted in areas with a high probability of containing shipwrecks. Construction of erosion devices such as weirs or dikes, or the building or removal of canal banks can adversely impact any prehistoric or historic site in the immediate impact area. In all cases these actions need to be examined on a project by project basis.

<TABLE LIKE THIS CAN BE PREPARED TO SHOW MARSH MANAGEMENT ACTIONS>

ALTERNATIVE PROPOSED	CONTROL MEASURE	CULTURAL RESOURCE	POSSIBLE IMPACT
MARSH MANAGEMENT			
HYDROLOGIC RESTORATION			
OUTFALL MANAGEMENT			
SEDIMENT DIVERSION			
FRESHWATER DIVERSION			
MARSH CREATION WITH DREDGED MATERIAL			
BARRIER ISLAND RESTORATION			
SHORELINE EROSION CONTROL WITH STRUCTURES			
SHORELINE EROSION CONTROL WITH VEGETATION			
TERRACING			
SEDIMENT TRAPPING			
HERBIVORE CONTROL			

SIGNIFICANT ITEMS AND EFFECTS OF MARSH MANAGEMENT ACTIONS. Actions such as plugging or filling canals, or removing canal banks or causing gaps to increase sheet flow into an area, could impact significant....ADD......

As a result of coordinationin the past, such as the one developed by the Natural and Cultural Resources Analysis Section for the CWPPRA Task Force, an memorandum of agreement with the State Historic Preservation Office was established which outlines procedures to follow in meeting cultural resource compliance. The Colonel acting on behalf of the Task Force and the State Historic Preservation Officer have signed this document. The Task Force composed of both state and federal agencies has agreed to follow the procedures as stated in .... ???????

SUMMARY BY BASIN

	NAME OF BASIN	CULT. RES SURVEYS	ARCH. SITES	NATIONAL REGISTER PROPERTIES
1	Calcasieu\Sabine 2 parishes	109	263	5
2	Mermentau 2 parishes	83	203	2
3	Teche/Vermilion 3 parishes	133	347	26
4	Atchafalaya 2 parishes	90	212	24
5	Terrebonne 5 parishes	259	764	40
6	Barataria 8 parishes	422	873	38
7	Breton 2 parishes	111	294	7
8	Pontchartrain 10 parishes	493	1056	134
9	Mississippi R. Delta 1 parish	76	152	4

DISCUSS
Problem of# of surveys being duplicated since data is keep by paris and not by basin at the State Historic Preservation Office counts by parish

1. Calcasieu /Sabine Basin

2. Mermentau Basin

3. Teche/ Vermilion

4. Atchafalaya Basin

5. Terrebonne Basin

6. Barataria Basin

7. Breton Basin

8. Pontchartrain Basin

9. Mississippi River Delta

Approximately 30 man hours has been expended on this project due to lack of funds for this adspect of the EIS and my prsent work load....as soon as more funds are available this can be completed

General information on the number of cultural resources in the area and a listing of all cultural resources surveys by parish has been gathered.

Future work needed to be done includes a more detailed evaluation of the types of cultural resources in the ten basins; types of impacts expected from marsh management projects which could affect cultural resources. Recommendations will be presented which could better provide data for National Historic Preservation Act compliance, as well as other environmental compliance such as NEPA.

NO ACTION ---FUTURE CONDITIONS WITHOUT MARSH MANAGEMENT EFFORTS
Land surfaces in the coastal zone will continue to erode and in some instances could cause loss of cultural resources. Many of these fragile archeological sites in the wetlands may be adversely impacted by destructive natural forces such as subsidence and erosion. Other destructive forces attributed to man such as wave action from passing ships, or construction activities will also continue to destroy cultural resources in these areas.

K - FWS's Permit Process Narrative

United States Department of the Interior

FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II, Suite 102
Lafayette, Louisiana 70508

November 19, 1991

Mr. R. H. Schroeder, Jr.
Chief, Planning Division
U. S. Army, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Schroeder:

Reference is made to your October 22, 1991, letter requesting a description of the Fish and Wildlife Service's role in marsh management permitting. The requested information is to be used by your office to prepare a programmatic environmental impact statement addressing marsh management. The following input is provided on a technical assistance basis.

Under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.), the Fish and Wildlife Service (Service) reviews Section 10/404 permit requests for marsh management activities. The Service provides its findings and recommendations on specific permit requests in reports transmitted to the Corps of Engineers. Service reports on marsh management permit requests typically contain recommendations to modify the design, number, location and/or operation of water control structures. Such modifications are intended to minimize adverse impacts on fish and shellfish nursery use of the affected wetlands, to reduce or eliminate excessive ponding of emergent vegetation, and to increase the success of proposed drawdowns in the restoration of emergent plant coverage in deteriorated wetlands.

Under the authority of the Endangered Species Act of 1973 (as amended), the Service also reviews marsh management permit requests for potential impacts on threatened or endangered species. When adverse impacts are anticipated, the Service advises the Corps of Engineers and provides recommendations to minimize those impacts.

The Service believes that properly planned and operated marsh management projects can be a useful tool in reducing wetland loss and restoring degraded wetlands in coastal Louisiana. We recognize that intensive marsh management may reduce access by estuarine fishes and shellfishes. Through case-by-case review of individual marsh management project proposals, we seek to achieve an optimum balance between long-term wetland conservation and use of managed areas by estuarine organisms.

L - NMFS's Permit Process Narrative

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
c/o LSU Center for Wetland Resources
Baton Rouge, Louisiana 70803-7535

November 5, 1991 F/SE024/RH:jk
504/389-0508

Mr. R. H. Schroeder, Jr.
Chief, Planning Division
Department of the Army
New Orleans District, Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Mr. Schroeder:

The Baton Rouge office of the National Marine Fisheries Service (NMFS) has received your October 22, 1991, letter requesting a written description of the NMFS review process regarding marsh management permit matters in Louisiana. The following discussion provides the information you requested.

The NMFS is the primary federal resource agency responsible for the management and conservation of marine fishery resources and their habitats. Through review and advisory opportunities afforded by the Fish and Wildlife Coordination Act, the Clean Water Act, the National Environmental Policy Act, and other laws and regulations we consult with federal agencies proposing to construct, permit, or license projects potentially affecting marine fishery resources and their habitats. Some of these resources (e.g., shrimp and red drum) are federally managed through plans developed under the Fishery Conservation and Management Act.

From 1980 through 1990, the NMFS reviewed over 130 public notices advertising marsh management projects. The NMFS recommended permit denial of, or revisions to, approximately 70% of those projects. One reason for our opposition is the impact of water control structures and levees on the production and standing crop of commercially and recreationally valuable marine fishery resources. Researchers have documented significant adverse impacts of marsh management activities to estuarine-dependent fisheries. Herke et al. (1987)[1] reported average decreases of 78% in the production of penaeid shrimp, gulf menhaden, spotted and sand seatrout, and red and black drum, as a result of water management using a water control structure (weir) with a crest elevation of 12 inches below

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1 Herke, W.H., E.E. Knudsen, Z.X. Chen, N.S. Green, P.A. Knudsen, and B.D. Rogers 1987. Final report for the Cameron-Creole watershed fisheries investigation. Baton Rouge: Louisiana State University, School of Forestry, Wildlife and Fisheries, Louisiana Cooperative Fish and Wildlife Research Unit. 419 pp.

non-critical periods, or opening structures entirely during peak ingress events. The intent is to maximize fishery access while permitting the landowner to manage the property.

A second recommendation is to reduce the duration of fish-excluding events. For example, we believe authorization of frequent or prolonged drawdowns to stimulate vegetation growth is inappropriate. Normally, short and infrequent drawdowns can achieve a desirable level of revegetation. In addition, if structures are to be operated to hold water on the marsh to provide access for hunting or trapping, we recommend the structures be set at low elevations and closed no sooner than one month prior to the hunting/trapping season and opened immediately after the end of the season.

A third recommendation is to alter the salinity closure criteria. Some projects have proposed salinity management objectives that allow structures to be completely closed most of the time. We believe this is unwarranted and that the structure closure provision should be set such that only peak salinities are excluded.

A final recommendation we often make is to implement or improve a monitoring plan. Although marshes have been managed for many years, monitoring of implemented projects has been inadequate. There is a clear need to learn more about adverse and beneficial impacts of marsh management before greater commitments to marsh management are made. In those areas where monitoring has shown management to be unproductive or having adverse impacts, we believe management practices should be discontinued or the plans revised based on sound scientific data.

If you require additional information, contact me or staff of this office at your convenience.

Sincerely yours,

Rickey N Ruebsamen

Rickey N. Ruebsamen
Branch Chief

M - NRCS's Project Process Narrative

The USDA - Natural Resources Conservation Service (NRCS), formerly the USDA Soil Conservation Service, provides technical assistance to clients in developing Conservation Management Systems (CMS) based on a well defined planning process and policy. Adherence to this process and policy sometimes results in developing a CMS that fits the definition of "marsh management". CMSs address specific conditions in each marsh or area being planned as well as adjoining areas that may be impacted by the implementation of the planned practices or measures.

NRCS policy requires their resource planners to address all concerns identified for the five recognized natural resources (soil, water, animals, plants, and air) plus human considerations (social, cultural, economic, access, objectives, etc.). A Conservation Management System meets the minimum quality criteria for all resource concerns or impacts for the planned area as well as the surrounding area. The minimum quality criteria, as defined in the NRCS Field Office Technical Guide, prevents the degradation of the resources and assure their sustained use and productivity while considering the social and economical needs of the client and the surrounding area.

Planning starts when a client (the person or agency representative responsible for making land use decisions) enters into a cooperative agreement with the local Soil and Water Conservation District (SWCD).

NRCS uses a nine step planning process when developing a Conservation Management System (CMS). The nine steps are:
1) Identify the problems; 2) determine the objective; 3) inventory the resources; 4) analyze the resource data; 5) develop alternative plans; 6) evaluate plans; 7) client determines a course of action; 8) client implements the plan; 9) evaluation or monitoring of the results of the plan.

A team approach is used to develop a coastal wetland conservation management system. Team members include: soil scientists, engineers, biologists, plant specialists, hydrologists, agronomist, economists, range conservationist, and specialists from within NRCS as well as from other local, state, and federal resource management agencies. NRCS incorporates research, practical experience, and regulatory requirements to all CMSs. NRCS continues to fine-tune planning strategies that have been evolving over the last 40 years. Subjecting development of conservation management systems to this process ensures that final plans receive intense technical review while proper consideration is given to the many significant resource issues.

Once resource problems are identified team members assist the cooperator in developing the plans objectives. NRCS develops a resource inventory that includes historic and existing conditions for each of the conservation treatment units in the plan area and surrounding areas. Inventory data includes; historic and existing information on vegetation communities; hydrologic patterns; soil information; animal and fish species; water levels and salinity; evaluation of pond bottoms, waterways, marsh level and any levees and/or ridges; size and condition of all existing structures; size of all water exchange points between each conservation treatment unit and the adjoining area; and land loss trends.

NRCS encourages cooperators to request an interagency review of the project area early in the planning process. Normally, this occurs as soon as the problems have been identified, the objectives developed, and an inventory of the resources has been completed. The interagency meeting allows the regulatory and the commenting agencies the opportunity to visit the plan area and discuss any resource concerns. The agencies also provide recommendations for potential plan alternatives to meet the cooperators objectives and address their agency resource concerns.

Following the interagency meeting, NRCS develops alternative comprised of one or more conservation practices or measures that meet the cooperator's objectives. CMSs are designed to allow the maximum sustainable utilization of a wetlands area by all plant and animal species that would naturally inhabit the marsh type, as long as the basic objective of protecting the soil and plant community is not compromised. Habitat or access requirements for some species does at times, conflict with this basic objective. Protection of the basic resource receives top priority even though it could mean reducing access or other habitat requirements of specific species.

Once the cooperator determining a course of action, NRCS prepares the Conservation Management Systems or "Marsh Management Plan". The plan includes: overall plan objectives; all resource information (listed above); the objectives for each individual conservation treatment unit; list of conservation practices or measures to be implemented to obtain the planned objectives; the design drawing of all structure measures; the water management scheme for each water control structure; and a monitoring plan. The plan also includes maps that show the project structure locations, vicinity, and soils.

NRCS encourages the cooperator to send each of the regulatory and commenting resource agencies a copy of the CMS and requests the USACE to call another interagency meeting. This meeting allows the regulatory and commenting agencies another opportunity to comment on the plan prior to the application for all necessary state and federal permits. NRCS works with the cooperator to address all of the agencies concerns and whenever possible recommends revisions to the plan that will address these concerns, as long as the planned objectives can be achieved.

NRCS also assists the cooperator in developing a permit application and works closely with the cooperator during the permitting process.

N - LaDNR's Permit Process Narrative

The Louisiana State and Local Coastal Resources Management Act (SLCRMA) was passed, in response to the Federal Coastal Zone Management Act, in 1978 to protect, develop, restore and enhance the resources of the state's coastal zone. Marsh management plans are a regulated activity under SCLRMA. Section 214.22 of these revised statutes declares it is the public policy of the state to support and encourage multiple use of coastal resources consistent with the maintenance and enhancement of renewable resource management and productivity, the need to provide for adequate economic growth and development and the minimization of adverse effects of one resource use upon another without imposing any undue restriction on any user. It is also Louisiana's public policy to employ procedures and practices that resolve conflicts among competing uses within the Louisiana Coastal Zone.

With this in mind, Coastal Management Divisions's responsibility is to achieve the proper balance between coastal resource use, and the conservation, protection and enhancement of wetlands and other coastal resources. Our mandate is to balance the impacts and benefits of proposed coastal resource uses, and resolve conflicts between competing uses, for the overall well-being of those resources which are the property of the citizens of Louisiana. Toward this goal, one of CMD's chief objectives in the review of individual marsh management plans is the resolution or attainment of a compromise between the often competing mandates or concerns of various Federal and State resource agencies, land owners and the general public.

CMD has two sections responsible for the review of marsh management plans. The review of marsh management plans proposed by a Federal agency, or proposed on Federally owned or controlled property, is carried out by the Consistency Section of the Interagency Affairs Branch; conversely, the review of marsh management plans proposed by private citizens, or private companies, or proposed on privately owned property, is carried out by the Permits Section of the Permits and Mitigation Branch.

Marsh management plans proposed by Federal agencies are Direct Federal Actions and are processed as such by the Consistency Section. National Oceanic and Atmospheric Administration (NOAA) regulations at 15 CFR Section 930.30-930.44 require that the federal agency submit to the state program a Consistency Determination and supporting information at the earliest possible time in the planning of the activity. This Determination is made by the federal agency after reviewing the proposed activity in light of the applicable requirements of the state program.

In order to be considered complete, Consistency Determinations generally must include a vicinity map, and a detailed description and plats of the proposed activities, including any dredging or filling (indicating locations, volume of material, disposal sites, etc.), structures or facilities, and means of access. If available, a copy of National Environmental Policy Act (NEPA) documentation (e.g. Environmental Assessments or Environmental Impact Statements) is required. If the U. S.

Army Corps of Engineers will require a Section 10/404 permit, a copy of the permit application is also required for the Consistency Determination. Finally, pursuant to 15 CFR Section 930.39, the agency must certify that the proposed work is consistent to the maximum extent practicable with the State of Louisiana's Coastal Management Program.

Department of Natural Resources (DNR) decisions regarding Direct Federal Actions are due within 45 days of receipt of the Consistency Decisions. NOAA regulations provide the state a 15-day extension to that review period when the state notifies the federal agency proposing the project that such an extension is necessary. All projects for which Consistency Determinations are requested undergo a minimum two week public notice period.

If the proposed marsh management plan is to be located on Federally owned or controlled property, but is not to be implemented by a Federal agency, the plan is processed as a Federal License or Permit. All of the information requirements are the same as for Direct Federal Actions. However, the applicant must certify that the proposed work is consistent with the State of Louisiana's Coastal Management Program. Department of Natural Resources (DNR) decisions regarding Federal License or Permits are due within three months of receipt of the Consistency Determination. NOAA regulations provide the state an additional three month extension to that review period when the state notifies the applicant proposing the project that such an extension is necessary. These time frames assume that all necessary information concerning the proposed project have been made available for review.

If the proposed marsh management plan is to be conducted by private individuals or companies, and proposed on privately owned property, the review of the marsh management plan is carried out by the Permits Section of the Permits and Mitigation Branch. Applying for a Coastal Use Permit is not difficult but it does require attention to detail. If the information or drawings provided are inadequate, the permitting process will be delayed. If the application is not considered complete, the applicant will be contacted by the Joint Public Notice Coordinator and instructed as to what information is needed. Coastal Use Permit Application Information Packets can be obtained from CMD; this packet contains detailed information and instructions.

Once the application is determined to be complete, the application package is assigned to a permit analyst. A public notice is usually issued; this requires a thirty day minimum public comment period. The analyst starts coordinating with other state and Federal agencies to determine the merits of the proposed plan and what changes, if any are needed to satisfy agency guidelines and/or mandates; there is usually an interagency field investigation. Once a consensus is reached, the permit is issued.

Whether processed as a Consistency Determination or a Coastal Use Permit, the plan is checked for compliance with the following coastal use guidelines which are part of the enforceable policies of the Louisiana Coastal Resources Program:

Guideline 1.6 Information regarding the following general factors shall be utilized in evaluating whether the proposed use is in compliance with the guidelines.

a) type, nature and location of use

b) elevation, soil and water conditions and flood and storm hazard characteristics of site.

c) techniques and materials used in construction, operation and maintenance of use.

d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity and salinity; and impacts on them.

e) availability of feasible alternative sites or methods for implementing the use.

f) designation of the area for certain uses as part of a local program.

g) economic need for use and extent of impacts of use on economy of locality.

h) extent of resulting public and private benefits.

i) extent of coastal water dependency of the use.

j) existence of necessary infrastructure to support the use and public costs resulting from use.

k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.

l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.

m) the extent to which regional, state and national interests are served including the national interest in resources and the siting of facilities in the coastal zones as identified in the coastal resources program.

n) proximity to, and extent of impacts on, special areas, particular areas, or other areas of particular concern of the state program or local programs.

o) likelihood of, and extent of impacts of, resulting secondary impacts and cumulative impacts.

p) proximity to and extent of impacts on public lands or works, or historic, recreational or cultural resources.

q) extent of impacts on navigation, fishing, public access, and recreational opportunities.

r) extent of compatibility with natural and cultural setting.

s) extent of long term benefits or adverse impacts.

Guideline 1.7 It is the policy of the coastal resources program to avoid the following adverse impacts. To this end, all uses and activities shall be planned, sited, designed, constructed, operated and maintained to avoid to the maximum extent practicable significant:

a) reductions in the natural supply of sediment and nutrients to the coastal system by alterations of freshwater flow.

b) adverse economic impacts on the locality of the use and affected governmental bodies.

c) detrimental discharges of inorganic nutrient compounds into coastal waters.

d) alterations in the natural concentration of oxygen in coastal waters.

e) destruction or adverse alterations of streams, wetland, tidal passes, inshore waters and water bottoms, beaches, dunes, barrier islands, and other natural biologically valuable areas or protective coastal features.

f) adverse disruption of existing social patterns.

g) alterations of the natural temperature regime of coastal waters.

h) detrimental changes in existing salinity regimes.

i) detrimental changes in littoral and sediment transport processes.

j) adverse effects of cumulative impacts.

k) detrimental discharges of suspended solids into coastal waters, including turbidity resulting from dredging.

l) reductions or blockage of water flow or natural circulation patterns within or into an estuarine system or a wetland forest.

m) discharges of pathogens or toxic substances into coastal waters.

n) adverse alteration or destruction of archaeological, historical or other cultural resources.

o) fostering of detrimental secondary impacts in undisturbed or biologically highly productive wetland areas.

p) adverse alteration or destruction of unique or valuable habitats, critical habitat for endangered species, important wildlife or fishery breeding or nursery areas, designated wildlife management or sanctuary areas, or forest lands.

q) adverse alteration or destruction of public parks, shoreline access points, public works, designated recreation areas, scenic rivers, or other areas of public use and concern.

r) adverse disruptions of coastal wildlife and fishery migratory patterns.

s) land loss, erosion and subsidence.

t) increases in the potential for flood, hurricane or other storm damage, or increases in the likelihood that damage will occur from such hazards.

u) reductions in the long term biological productivity of the coastal ecosystem.

In addition to the above general use guidelines, the following specific guidelines for hydrologic and sediment transport modifications apply:

Guideline 7.1 The controlled diversion of sediment-laden waters to initiate new cycles of marsh building and sediment nourishment shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the

outfall area. Such diversions shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Guideline 7.2 Sediment deposition systems may be used to offset land loss, to create or restore wetland areas or enhance building characteristics of a development site. Such systems shall only be utilized as part of an approved plan. Sediment from these systems shall only be discharged in the area that the proposed use is to be accomplished.

Guideline 7.3 Undesirable deposition of sediments in sensitive habitat or navigation areas shall be avoided through the use of the best preventive techniques.

Guideline 7.4 The diversion of freshwater through siphons and controlled conduits and channels, and overland flow to offset saltwater intrusion and to introduce nutrients into wetlands shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the outfall area. Such diversion shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Guideline 7.5 Water or marsh management plans shall result in an overall benefit to the productivity of the area.

Guideline 7.6 Water control structures shall be assessed separately based on their individual merits and impacts and in relation to their overall water or marsh management plan of which they are a part.

Guideline 7.7 Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds," permit tidal exchange in tidal areas, and minimize obstruction of the migration of aquatic organisms.

Guideline 7.8 Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

Guideline 7.9 Withdrawal of surface and ground water shall not result in saltwater intrusion or land subsidence to the maximum extent practicable.

Coastal Management encourages an applicant for an individual marsh management permit or consistency to contact our office and arrange a pre-application meeting to make the process as

efficient as possible for obtaining an individual Coastal Use Permit or Consistency. For further information please contact Mr. Gregory J. DuCote, Interagency Affairs Program Manager or Mr. Rocky Hinds, Permits and Mitigation Program Manager at 1-800-267-4019.

O - EPA's Permit Process Narrative

The United States Environmental Protection Agency has initiated a process that will result in the formulation of a policy on the management of marshes. In lieu of promulgation of that policy, the Agency has submitted the following:

Under Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA) jointly administer the 404 permit program.

Under Section 404, the COE is authorized to issue permits for the discharge of dredged or fill material into waters of the United States, subject to an EPA "veto" if the discharge has certain unacceptable impacts. EPA has the authority to review each permit application and to submit comments pursuant to the 404(b)(1) guidelines. The 404(b)(1) guidelines were developed by EPA in conjunction with the COE to evaluate proposed discharges of dredged or fill material. Utilizing the guidelines, an EPA permit review focuses on evaluating practicable alternatives, minimizing impacts, and mitigating for unavoidable impacts to the aquatic ecosystem, including wetlands.

Section 404(c) of the Clean Water Act gives EPA the authority to "veto" a permit if the discharge will have unacceptable adverse impacts on the aquatic or wetland ecosystem.

P - NOD's Permit Processing Narrative

The Corps of Engineers issues permits for MM under the authorities of Section 10 of the River and Harbor Act and Section 404 of the Clean Water Act. Section 10 authorization is needed for dredging and other work, such as the installation of structures, in or affecting navigable waters, including tidal wetlands. Section 404 authorization pertains to the deposition of dredged or fill material in waters of the United States, which includes navigable waters and adjacent wetlands. As part of our evaluation leading to a permit decision, we conduct a public interest review to ensure that the activity is not contrary to the overall public interest. This review relies heavily upon comments which we solicit from the general public and from various resource agencies by issuing a public notice describing the project. All comments which we receive are compiled and addressed in an environmental assessment which also describes the purpose and need for the project, discusses alternatives which would eliminate or reduce project impacts and assesses the beneficial and adverse project impacts. In addition to preparing the environmental assessment, which is required by the National Environmental Policy Act (NEPA), we also perform a 404(b)(1) evaluation to ensure that the project complies with guidelines set forth under the Clean Water Act. The amount of time required to complete processing varies greatly and may range anywhere from a few months to over a year. Delays are most often caused by having to request additional information from the applicant and by attempting to resolve objections to the project. It is also important to note that most MM plans require permits from the Louisiana Department of Natural Resources Coastal Management Division (CMD) and the Department of Environmental Quality Office of Water Resources (DEQ). We cannot issue our permit until after these state authorizations have been granted.

The majority of MM plans which we process are located within the Louisiana Coastal Zone (CZ); therefore, they are processed jointly by us and CMD. For those projects in CZ, the applicant submits his application to CMD who then forwards a copy to us for processing. If the project is outside the CZ boundaries, the applicant submits his application directly to us. The incoming application is assigned to a project manager who is responsible for all aspects of processing as well as post-issuance inspections and review of monitoring data. In order for us to begin processing, the application package must contain a clear vicinity map, a drawing showing the management area, various subunits or conservation treatment units, if applicable, and structure locations, a plan view and cross-section of proposed work, quantities of dredged and/or fill material, structure diagrams and an operational scheme for the structures. The application must also contain a statement describing the purpose of the project and a list of

adjacent landowners. We will contact the applicant or agent and request any information which has not been provided. Once we have all of this information, we issue a public notice describing the project. For projects inside the CZ, the public notice is usually issued jointly with CMD, which means that only one public notice is used to solicit comments for our permit program and CMD's. The public notice is distributed to all adjacent landowners, numerous state and federal agencies, and individuals and organizations
on our public notice mailing list. We forward comments we receive during the comment period (usually 20 days) to the applicant for his consideration. The applicant is not required to address objections; however, he must inform us of whether or not he intends to rebut or attempt to resolve them.

During the comment period we typically receive comments from the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. For projects in the CZ, state agencies submit their comments directly to CMD with copies to us. We are required to give full consideration to comments which we receive from the various federal agencies. Because these agencies have different mandates, their comments and recommendations often conflict with one another, and we are faced with the difficult task of evaluating the validity of these comments and deciding which of the recommendations, if any, to require the applicant to adopt. The decision is made even more difficult due to the widely differing opinions as to the effectiveness and impacts of MM. Although we have had several instances when one or more of the agencies recommended denial of a MM plan, recommendations most often received during the public notice comment period usually involve changes in the design or operation of proposed water control structures. We attempt to satisfy the concerns of all of the agencies; however, in most cases this is impossible because of their differing views. Typically, we recommend a plan which is a compromise between all parties involved; however, we will not recommend changes if we do not find them to be necessary, if they are not practicable or if they would defeat the purpose of the project. If we determine that a project would result in unacceptable adverse impacts and that the project cannot be modified without defeating the objectives, we will deny the permit. In all cases, we have the responsibility for making the final permit decision. Agency input is only utilized to the extent that it assists us in making our decision.

Agency comments usually assist us in evaluating environmental impacts which may be caused by a particular MM project. However, we must also address many other factors which are beyond the purview of any one agency. We must consider the applicant's purpose and need for the project and weigh the anticipated benefits against any adverse impacts which are

likely to occur. We take into account a host of environmental and socioeconomic concerns such as impacts to hydrologic patterns, substrate conditions, flood control functions, navigation, water quality, air quality, wetlands and wetland-dependent resources, threatened and endangered species, cultural resources, aesthetics, economics, safety and energy needs. We are also required to address secondary and cumulative impacts which the project may cause or contribute to. In the event we determine that impacts would be significant, NEPA requires that we prepare an Environmental Impact Statement (EIS), which necessitates a much more rigorous evaluation of the project. Despite the tendency by many to argue for or against a particular project based upon generalizations about MM, we never lose sight of the fact that each project and each project site is different. Although previous studies or prior experience in other areas may give us some clues as to what may or may not happen if a plan we are considering is implemented, we evaluate each plan on its own merit using the best and most relevant information available to us at that time.

In order for us to evaluate the project and to address recommendations submitted by the agencies, we generally have to request that the applicant provide additional information. Much of this information is necessary in order to document the need for the project and to determine how the project will affect the physical environment and biological resources in the proposed management area as well as in surrounding areas. Information typically requested includes data on hydrologic patterns and water levels, historical salinity data, land loss trends in the area and biological resources on the property. We may also request that the applicant consider various alternatives which we believe may accomplish project objectives while minimizing potential adverse effects. During or prior to our evaluation, we normally arrange a trip to the site in order to gain a better appreciation of what the applicant is attempting to accomplish and what resources may be affected.

The evaluation phase of the permit process often causes the most lengthy delays; therefore, it is highly recommended that an applicant arrange an interagency meeting and/or field trip even before he submits his application. A pre-application meeting educates the agencies on what the applicant wants to accomplish and also lets the applicant know what the various agency positions will be. The applicant may elect to incorporate agency recommendations at this time so that at least some of their concerns are addressed prior to making application and going on public notice. Changes made late in the process may cause delays because of the need to prepare new drawings, coordinate the changes with the various agencies and in cases where the changes are substantial, to issue a new

public notice.

If we are satisfied that the project is needed, that it is the least environmentally damaging practicable means to accomplish project objectives and complies with other provisions of the 404(b)(1) guidelines and that the work is not contrary to the overall public interest (i.e., anticipated benefits outweigh the potential negative impacts), we will issue a permit. As mentioned previously, permits for projects requiring a Coastal Use Permit from CMD or Water Quality Certification from DEQ cannot be issued until these authorizations have been granted. Our MM permits are conditioned to require that the applicant adhere to the water control structure operational schedule agreed upon during the permit process. In addition, they typically contain requirements for monitoring specific physical and/or biological parameters in order to determine if the project is effective in accomplishing its objectives and to ensure that it is not causing unacceptable adverse impacts. We believe monitoring to be necessary given the uncertainties involved in predicting MM impacts. It also provides the applicant with information needed to make wise management decisions in the event the management plan is not working effectively.

Once we make a preliminary decision to issue a permit, we are required to notify any of the federal agencies which have unresolved objections to the project. Under certain circumstances, an agency disagreeing with our decision may request that the decision be "elevated" to a higher level. This referral procedure and the circumstances allowing such a referral are spelled out in Memoranda of Agreement with the various federal agencies. This process could delay final action by several months; however, we have rarely had a MM permit decision referred for higher level review.

Q - Candidate CWPPRA HM Projects Profiles and Data Analyses

The tidal signals within every one of the managed areas would be only partially reflective of the biological and physico-chemical rhythms and dynamics of the hydrologic signal in the unmanaged portion of the estuary. Generally, the frequency, direction and duration of communications hydrologically managed areas would retain with the unmanaged estuary would be reduced to what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh, or when water was allowed to pass through structures (please see Appendix B for a discussion of the effects of typical structures). Deviations from this general scenario are noted.

Additionally, dampening the biological and physico-chemical rhythms and dynamics of the hydrologic signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to slowing marsh losses, invigorating existing marsh and expanding the amount of submerged aquatic vegetation. For some projects, intentionally inducing hydrologic differences would apparently be a separate way to add to benefits derived from arresting shoreline erosion.

Q.1. **Profiles of Individual Pontchartrain Basin CWPPRA HM Projects**

Overview of Basin Land Loss (See also Appendix H)

Exposed and protruding portions of the Lakes Pontchartrain and Borgne shorelines (especially the Lake Pontchartrain shoreline near Chef Pass), Mississippi, Breton and Chandeleur Sounds, and the northern bankline of the Mississippi River Gulf Outlet are likely to continue to experience high rates of erosion due to wind or vessel wave action. If continued wave action breaks through the exposed shorelines, nearby small ponds will begin to erode at much faster rates. In Lake Pontchartrain, the potential appears to be greater near Point aux Herbes, south of Goose Lake (near Lacombe, La) and along a nearly four-mile stretch of lake shoreline just southwesterly from Pass Manchac. Proctor Point in Lake Borgne and the marshes that form rims of Chandeleur, Breton and Mississippi Sounds are vulnerable.

Disrupted hydrologies are likely to be the reason for continued high erosion rates in the marsh associated with Bayou Sauvage, Fritchie marsh and the lake fringe marshes south of Slidell, LA.

Summary of the Basin's Candidate CWPPRA HM Projects

Four candidate CWPPRA HM projects are assumed to be viable

candidates for future implementation (Plates 1 and 2, Tables 22, 29 and 35, Figure 24). One has already been permitted and discussed under that heading. Collectively, the other three could encompass 13,170 acres. Of that total, 9,255 previously unmanaged acres could be brought under management and the management of 3,915 acres could be sustained .

All four candidate projects are intended to slow marsh losses, invigorate existing marsh and expand the amount of submerged aquatic vegetation. Historic and continued interior marsh losses are perceived as concerns for two project areas and continued shoreline losses are perceived as concerns in three of the four project areas.

HR (passively operated) would be the management option of choice to sustain the management of two areas (5,170 acres). HR (actively operated) was the management option of choice applied to a 15,578-acre previously permitted project. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. MM (active) would be the management option of choice to establish a first-time management presence on one 8,000-acre project area.

Differing degrees of reduced tidal signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to slowing marsh losses, invigorating existing marsh and expanding the amount of submerged aquatic vegetation. For some projects, intentionally inducing hydrologic differences would apparently be a separate way to add to benefits derived from arresting shoreline erosion.

The projects exhibit a disconnected spatial relationship to one another (Plates 1 and 2). However, the two projects in the Pontchartrain/Borgne Land Bridge Sub-basin would collectively account for 19,593 acres (26 % of that sub-basin's marsh/water complex) and have impacts and effects in excess of that acreage because of the substantial amount of wetlands/water already under management (e.g., Bayou Sauvage NWR). Elsewhere, the impacts and effects of the other two projects are more likely to occur within or in the immediate vicinity of each project area.

Also see main text at 5.2.1.1.

Individual Project Profiles

Project **PO-11** encompasses a 3,915-acre currently managed brackish marsh area that has exhibited relatively high historic internal marsh losses, especially during the 1932-1974 time frame. That trend might accelerate. To mimic

historic conditions this passively operated HR project involves rehabilitating debilitated water control structures (i.e., filling-in gaps in existing embankments, installing a rock plug and earthen dam) to reestablish control of the area's hydrology to reduce tidal scour and salinity intrusions.

Project **PO-15** encompasses a 15,578-acre brackish marsh area that has exhibited minimal internal land loss but relatively high shoreline erosion throughout the period of record. Shoreline erosion is expected to persist. Internal marsh losses that may be occurring are not anticipated to accelerate. Marsh losses could accelerate if the shoreline is breached. To mimic historic conditions this actively operated HR project, previously permitted as a waterfowl/marsh restoration active MM project, involves the installation of new perimeter water control structures (i.e., earthen dams, variable crest weirs, timber/sheetpile and/or rock weirs) to gain control of the area's hydrology to reduce erosive tidal scour and control salinity. Some natural waterways will not be impeded; however, several routes will remain open.

Project **XPO-51** encompasses a 8,000-acre previously unmanaged intermediate marsh area that has exhibited minimal internal land loss but relatively high shoreline erosion throughout the period of record. The targeted area is the Manchac Wildlife Management Area, a property administered by the Louisiana Department of Wildlife and Fisheries. Shoreline erosion is expected to persist but any internal marsh losses that may be occurring are not anticipated to accelerate. This actively operated MM project involves the installation of new water control structures (i.e., variable crest weirs fitted with flapgates) and gapping canal banks at strategic locations along the perimeter to gain control of the area's hydrology.

Project **XPO-84** encompasses a 2,089-acre previously unmanaged brackish marsh area that has exhibited losses, especially during the 1958-1974 time frame. Very little internal marsh losses were recorded. Salt water intrusion and tidal action were the reasons implicated for the recorded erosion. To mimic historic conditions this passively operated HR project involves the installation of solid plugs in canals to reestablish control over the area's hydrology.

Q.2. Profiles of Individual Breton Basin CWPPRA HM Projects

Shoreline erosion is likely to be a major contributing factor to an overall slight increase in loss rate in the foreseeable future.

Areas already where high loss rates are expected to continue include marsh shoreline bordering Black Bay and Breton Sound (wind-driven wave action), the interior marshes between Braithwaite and Bertrandville, near Lake Leary and Bayou Terre aux Boeufs (altered surface hydrology), and the marshes near Bay Denesse and Little Coquille Bay (high subsidence, shoreline erosion, altered hydrology).

Higher loss rates may occur where shoreline breaches occur (e.g., Grand Lake, Lake Petit) or where manmade landscape features have altered hydrology (e.g., marshes near Carlisle River aux Chenes).

Also see main text at 5.2.1.2.

There are no CWPPRA HM projects proposed for this basin.

Q.3. **Profiles of Individual Barataria Basin CWPPRA HM Projects**

Overview of Basin Land Loss

Losses ongoing in this basin today are likely to continue at a relatively high rate. Other locations are likely to exhibit accelerated loss rates during the foreseeable future. Altered hydrology could accelerate the marsh loss rates affecting the marshes on both sides of the Providence Canal east of Lake Des Allemandes, the marshes southeast of Crown Point, LA, and the marshes astride the Freeport Sulphur Canal near Grand Bayou.

Accelerated interior losses would likely be recorded if the shoreline is breached along the northwestern portion of Lake Salvador, areas near Little Lake, in the vicinity of Bayou L'Ours, and the marshes surrounded by Bayous Perot and Rigolettes.

Summary of the Basins's Candidate CWPPRA HM Projects

Nine CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 4; Tables 24, 30 and 35; Figures 24). Two have already been permitted and discussed previously. Collectively, the reaming seven could encompass 68,087 acres. Of that total, 65,539 previously unmanaged acres could be brought under management and the management of 2,548 acres could sustained.

Seven projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. The two others have arresting shoreline erosion as a purpose. All nine areas have exhibited internal marsh losses during the period of record and

shoreline losses have occurred at two project areas.

Actively operated HR would be the management option of choice for seven of the nine project areas, collectively encompassing probably more than 28,000 acres. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. MM would be the management option of choice for two targeted areas (encompassing 29,498 acres of brackish and saline marsh/water). HR is apparently perceived to be implementable over fresh, intermediate and/or brackish marsh types, whether or not the management would be active or passive and regardless of the size of the project area.

The projects exhibit several spatial relationships to one another (Plate 4). Therefore, it is possible, even probable, that several of the projects could exert an influence on adjacent or nearby projects, and a certainty that pre-existing projects would be effected when located within the boundaries of larger projects. Whatsmore, the candidate CWPPRA HM projects would encompass most of the western wetlands/water complex of the Bay, North Bay, Central Marsh and Salvador Sub-basins (Plate 4).

See also main text at 5.2.1.3.

Individual Project profiles

The **BA-2** project area encompasses a 60,000-acre fresh/intermediate/brackish marsh area, portions of which are subject to management, that has exhibited considerable interior marsh loss during the 1974-1990 time period. Tidal scour and salinity intrusion resulting from prior hydrologic alterations are suspected to have been part of the historic problem in both project areas. Interior marsh loss for these same reasons is likely to continues. To mimic historic conditions, this actively operated HR project involves installing perimeter structures water control structures of unspecified design, solid plugs, 6-inch high dredged material embankment) to increase fresh water retention.

Project **BA-6** encompasses a 40,000-acre fresh/intermediate marsh area that has exhibited considerable losses during the period of record. Portions of the targeted marsh are subject to management. Man-made marsh loss (excavation of canals and failed agricultural efforts) from the 1930's to the 1970's accounts for most of the loss. More recent interior losses, presumably the result of tidal scour induced by altered hydrology, is expected to continue. To mimic historic conditions this actively operated HR project involves installing perimeter structures (i.e., rock weirs,

earthen plugs, 6-inch high dredged material embankment) and better managing pumped, fresher water and sediment inputs from existing forced drainage systems to increase fresh water and sediment retention and reduce tidal scour.

Project **BA-14** (involving 2,548 acres of brackish marsh) encompasses a currently managed area that has exhibited considerable interior marsh loss and some shoreline erosion throughout the period of record. Interior marsh losses due to subsidence and other effects altered hydrology has had on saltwater intrusion are expected to continue. This actively operated MM project involves the rehabilitation of old and installation of new perimeter structures of unspecified design to reacquire control of the area's hydrology to conduct active water level management.

Project **PBA-32** encompasses a 26,500-acre area of previously unmanaged brackish marsh that has exhibited considerable interior and some shoreline marsh loss during the period of record. Losses of both kinds are expected to continue. The preliminary design of this passively operated HR plan has not been formulated but will include shoreline erosion control features and the installation of plugs in canals.

Project **PBA-34** involves 24,785 acres of previously unmanaged brackish and saline marsh types that have exhibited high rates of interior marsh loss, especially during the 1958-1983 time periods. Saltwater intrusion and tidal scour, related to the initial excavation of petroleum extraction canals during the 1930-1958 and an expansion of those canals during the 1958-1974 time frame, is suspected to have been part of the historic problem. Interior marsh loss for these same reason is likely to continue. To mimic historic hydrologic conditions this actively operated HR project involves managing pumped-in fresher water and installing solid structures in breaches in the natural ridge to increase fresh water retention and reduce tidal scour. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be that which occurred from an unmuted tidal signal.

Project **PBA-35** involves 7,199 acres of previously unmanaged intermediate marsh that exhibited considerable losses during the period of record. Man-made losses (dredging of petroleum extraction canals primarily during the 1930-1958 time frame) and interior marsh loss account for most of the loss, although limited shoreline erosion losses have also occurred. Shoreline erosion and interior marsh losses, due primarily to tidal scour, are expected to continue. To mimic historic hydrologic conditions this passively operated HR project involves rehabilitating old (i.e., plugging breaches in existing embankments) and constructing new

perimeter structures (i.e., rock weirs, solid plugs in canals) to reduce tidal exchange and reduce salt water intrusion.

Project **PBA-58** involves 5,847 acres of previously unmanaged brackish marsh. The area targeted for management has exhibited marsh losses throughout the period of record. Man-made losses (excavation of oil field canals) and shoreline erosion during the 1930-1950's accounts for about one-half of the recorded losses. Internal marsh loses, attributed to salinity intrusion and tidal scour, during the 1950's-1974 and again during the 1983-1990 time frames accounts for the remaining marsh losses. To mimic historic hydrologic conditions this passively operated HR project involves the installation of plugs in numerous oil-field canals to reduce tidal exchange and possibly lower salinities.

Project **PBA-61** involves 3,994 acres of previously unmanaged fresh and intermediate marsh types. The area targeted for management has exhibited extensive shoreline erosional losses throughout the period of record. Man-made losses (dredging of petroleum extraction canals primarily during the 1930-1958 time frame) was also a cause of marsh loss. Shoreline erosion is expected to continue. To mimic historic hydrologic conditions this passively operated HR project involves the installation of solid plugs in canals.

Project **XBA-70** 3,900 acres of previously unmanaged brackish marsh. The area targeted for management has exhibited extensive marsh losses from the 1930's to the early 1980's. The western boundary of the area adjoins the Dupre Cut of the Barataria Waterway. Man-made looses (dredging of petroleum extraction canals and dredging of the Dupre Cut during the 1930-1958 time frame). That period was followed by extensive internal marsh losses during the 1956-1974 time frame attributed to salinity intrusion and tidal scour. Very little measurable losses have been recorded since then. To mimic historic hydrologic conditions, this actively operated HR project involves rehabilitation of the eastern bank of the Dupre Cut levee, including the installation of plugs and water control structures.

Q.4. **Profiles of Terrebonne Basin CWPPRA HM Projects**

Overview of Basin Land Loss

Areas experiencing relatively high rates of shoreline erosion will persist. Relatively high rates of loss will likely persist at Avoca Island, northeast of Lake Cocodrie, in the marshes between Lost Lake and Lake Decade, in the marshes south of Falgout Canal between Bayou du Large and

the Houma Navigation Canal, near Madison Bay, between Wonder Lake and Bayou Lafourche, east and south of Catfish Lake and north of Lake Boudreaux.

Areas that may evidence accelerated rates of loss are where shoreline breaches occur, south of Bayou Blue (west of Grand Bayou Canal), between Little Lake and Bayou Lafourche, and south of Lake de Cade.
Summary of the Basins's Candidate CWPPRA HM Projects

Twenty-two CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 5; Tables 25, 31, 35; Figure 24). However, only 18 are included in this discussion. Collectively, they encompass 189,171 acres. Of that total, 135,050 previously unmanaged acres could be brought under management for the first time (n = 14 projects), the management of 38,444 acres would be sustained (n = 2 projects) and management capability would be reacquired over 20,677 acres (n = 2 projects). Nearly all projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. One intends to forestall the onset of saltwater intrusion and two intent upon freshening marsh. Nearly two-thirds of the projects areas exhibited losses that spanned the period of record. However, the other of the projects exhibited losses which occurred predominantly prior to and through the 1974-1983 time frame and it these project areas, collectively encompassing 65,458 acres of all four marsh types, that comprise almost half of the total area to be brought under management for the first time.

Active forms of both HR and MM would be the predominant management options of choice. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. Most of the projects call for the construction of new perimeter water control features. Actively and passively operated HR and actively operated MM are apparently perceived to be implementable over fresh, intermediate and/or brackish marsh types, whether or not the management would be active or passive and regardless of the size of the project area, and independent of the extent and timing of the targeted losses.

The projects exhibit several spatial relationships to one another (Plate 5). Therefore, it is possible, even probable, that several of the projects could exert an influence on adjacent or nearby projects. Whatsmore, the candidate CWPPRA HM projects would encompass most of the wetlands/water complex of the Timbilier and Penchant Sub-basins (Plate 5).

See main text at 5.2.1.4.

The **PTE-26b** project area (7,653-acre previously unmanaged fresh/intermediate/brackish marsh) is Unit 8 of Project PTE-26 and encompasses an area that has exhibited considerable interior marsh loss during the period of record. This project area is bisected by a natural ridge. Both portions of the project area have exhibited interior marsh loss since the 1930's. However, the bulk of the recorded loss in one area occurred during the 1930-1974 time frames whereas the bulk of the loss in the other portion occurred during the 1958-1974 time frame. The timing of the losses may be correlated to the time period during which petroleum extraction canal systems were excavated. The impacts of altering hydrology (greater tidal amplitude and salt water intrusion) are suspected to have been part of the historic problem. Interior marsh loss for these same reasons is likely to continue in both areas. To mimic historic conditions this actively operated HR project involves the installation of perimeter structures consisting of one-way flapgated structures (to facilitate fresh water introductions), rock weirs (some with boat bays), and creation of 6-inch high dredged material embankments. The project area would be nearly completely surrounded by a hydrologic barrier with passively and actively managed water exchanges occurring most often at several specific locations. Thus, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. This project should be evaluated as dependent upon PTE-26.

Project **PTE-23/XTE-33** encompasses a 13,024-acre previously unmanaged brackish marsh area that has exhibited internal marsh losses mostly during the 1930-1974 time frames, man-made losses (excavation of petroleum extraction canals) during the same time frame and shoreline erosion, of internal ponds and along the entire perimeter of the area, throughout the entire period of record. The impacts of altering hydrology (greater tidal amplitude and saltwater intrusion) are suspected to have been part of the historic internal marsh problem. Shoreline erosion is expected to continue. Internal marsh losses may continue to occur, but at a rate that can't be detected easily using short-time frame photographic techniques. To mimic historic conditions this actively operated HR project involves installing rock weirs and spillway structures in oil field canals, installation of a low sill structure in a natural bayou and the rehabilitation of an existing plug and bulkhead.

Project **TE-5** is Gulf-ward of the Parish Line of Defense (XTE-28 project alignment). The project 5b area (a 19,130-acre previously unmanaged fresh/intermediate marsh area) has exhibited internal marsh losses in the eastern one-third of the project area spanning the 1958-1990 time frames. Pipeline and petroleum extraction canals cross and lead to the area from the south. The impacts of altering hydrology (greater tidal amplitude and saltwater intrusion) are suspected to have been part of the historic internal marsh problem. Internal marsh losses are likely to continue. This actively operated MM project involves the creation of a perimeter hydrologic barrier with dredged material fitted with variable crest weirs with flapgated culverts. The project area would become an actively managed semi-impoundment.

Project **TE-6** is Gulf-ward of the Parish Line of Defense (XTE-28 project alignment). The project area (a 5,407-acre previously unmanaged brackish marsh area) has exhibited a relatively high internal marsh loss during the 1958-1990 time frames. The effects of altered hydrology (greater tidal amplitude, saltwater intrusion) in the vicinity and subsidence are suspected to have been part of the historic problem. Because the area is largely shallow open water, wind-driven waves are expected to contribute to continuing erosion. This actively operated MM project involves construction of a perimeter levee, maintenance of a natural levee, and the installation of water control structures. The project area would become an actively managed semi-impoundment.

Project **TE-7** is a composite of four sub-projects, encompassing fresh, intermediate and brackish marsh types. Three of the four component project areas are on the land side of the Parish Line of Defense (XTE-28) alignment. Only component 7d (37,300 acres) is Gulf-ward of the XTE-28 alignment. All four component project areas have exhibited internal marsh loss. Losses in 7a (4,100 acres of fresh/intermediate marsh) appear to be related to the effects resulting from the excavation of a petroleum extraction canal system. Internal losses in 7b (3,000 acres of intermediate/brackish marsh) and 7c (1,600 acres of intermediate/brackish) are not easily linked to oil and gas exploration activities but do evidence ongoing shoreline erosion of Lake Boudreaux that spans the period of record. In 7d (intermediate/brackish), measurable erosion of the shorelines of naturally occurring open water areas occurred over discrete time frames in some instances and throughout the period of record in other nearby locations. The 4,100-acre 7a project area will be an actively operated MM area. Thus, the frequency, direction and duration of communications this managed area would retain with the

unmanaged estuary would be reduced to what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. The management of the other areas would be primarily passive. The hydrology of 7b and 7c would be reflective of the hydrological effects of XTE-28 on the Lake Boudreaux basin. The management scenario for 7d could include some active management. Thus, the frequency, direction and duration of communications those managed area would retain with the unmanaged estuary would be greatly muted, reduced to what was allowed to occur through or over water control structures and, in 7d only what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

The **TE-8** project area is on the landward side of the XTE-28 project alignment. The project area encompasses 2,400 acres of previously unmanaged intermediate marsh. The project area has exhibited internal marsh losses throughout the period of record. The bulk of those losses occurred in the southern portion of the project area during the 1930-1974 time frames. The effects of the Houma Navigation Canal (HNC), increased tidal amplitude, redirected surface flow patterns, possibly impeded drainage, and saltwater intrusion through breaches in the canal's embankments, are suspected to have been part of the historic problem. This actively operated MM project involves closure of embankment breaches and the installation of adjustable water control structures to facilitate fresh water retention, exchange and flow-through. Some active water level management is called for. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures that opened to the HNC. Otherwise this managed area would communicate with the managed marsh landward of the XTE-28 project.

Project **XTE-56** encompasses a 12,200-acre previously unmanaged parcel of the intermediate/brackish/saline marsh types that has exhibited interior marsh loss throughout the period of record but the bulk occurred during the 1930-1958 time frame. The losses are presumed related to the hydrological effects of the nearby HNC. Because the project area includes shallow open water areas, wind-driven waves are expected to contribute to continuing erosion. To mimic historic conditions this passively operated HR project involves sealing existing breaches in the HNC embankments and reinforcing locations where breaches of the HNC embankment are eminent. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be what occurred as a

function of an unmuted tidal signal.

Project **XTE-57** encompasses a previously unmanaged 6,090-acre brackish marsh area that has exhibited relatively high internal marsh loss, primarily during the 1930's-1974 time frame. Construction of pipeline and petroleum extraction canals during those time frames are suspected of having altered the hydrology. Because the project area includes shallow open water areas, wind-driven waves are expected to contribute to continuing erosion. To mimic historic conditions this passively operated hydrologic project involves installation of a water control structure to regulate inputs from a man-made canal to the north, placement of a solid plug in a pipeline canal and maintenance of some existing embankments to diminish inputs. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred in unaltered natural waterways and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

Project **XTE-47/XTE-48** would bring 5,200 acres of previously unmanaged the fresh/intermediate/brackish marsh types under management. The project area has exhibited localized internal marsh loss (during the 1958-1983 time frames), especially along the southern perimeter, in close association with a petroleum extraction canal system excavated during the 1930-1974 time frames. The canal system's effect on altering the hydrology is suspected of being part of the historical internal marsh loss problem. Any losses that may have occurred since then have not been measurable with aerial photography. Because the area contains shallow open water, wind-driven waves may contribute to any continuing erosion. This actively operated MM project involves the installation of drainage structures (design unspecified) and the control of fresh water inputs to facilitate a flow-through management situations.

The **TE-9** project area is wholly within the hydrologic boundaries of project XTE-47/XTE-48 but could be operated independently. The TE-9 project area (a 750-acre previously unmanaged brackish marsh) encompasses an area that has exhibited relatively high internal marsh loss during the 1954-1978 time frame. The effects of excavating petroleum extraction canals prior to and during that time frame are suspected of being part of the reason for the recorded marsh loss in the TE-9 project area. This actively operated MM project involves installation of variable-crest water control structures (to facilitate water level drawdowns) and embankment construction. The project area would become a semi-impoundment (for revegetation). As a semi-impoundment,

the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. However, even that degree of muted comminution could be further diminished because this project may be encircled by another project area that could also be actively managed.

Project **XTE-58** encompasses a 12,200-acre previously unmanaged brackish marsh area) that has exhibited internal, man-made and shoreline losses. The internal losses occurred throughout the period of record, often during or after the time period during which the man-made losses (pipeline and petroleum extraction canals) occurred. By comparison the shoreline losses on along the margins of larger, natural open water areas has been small. Marsh losses are expected to continue from all causes. To mimic historic conditions this passively operated HR project involves embankment maintenance, the construction of 6-inch high overflow embankments and the installation of several water control structures (to facilitate the input of and control direction of flow of fresher water and guard against impoundment).

The 138,250-acre previously unmanaged fresh/intermediate/brackish marsh types comprising the **PTE-25** project area are encompassed within other project footprints.
The **XTE-60** project would bring a 9,400-acre previously unmanaged brackish marsh area under management. However, project XTE-29 (see below) would more specifically involve 3,858 acres of this larger area. The remaining portion of the XTE-60 project are would bring 7,222 previously unmanaged acres under management. The XTE-60 project area is comprised of an area that has exhibited relatively high interior marsh loss that has occurred during the 1958-1990 time frames. Construction of pipeline and petroleum extraction canals during those time frames are suspected of having altered the hydrology. Losses in this and the nearby Madison Bay area to the south are expected to remain high. To mimic historic conditions this passively operated HR project involves work primarily along the southern boundary consisting of the installation of structures in selected man-made and natural waterways, the creation of marsh and the rebuilding of embankments. Because the upgraded southern boundary would consist largely of natural and recreated marsh, and structures in man-made waterways, the hydrology of the area would continue to be open to tidal exchange.

The **XTE-29** project area (a 3,500-ace previously unmanaged

brackish marsh area) is roughly the northern half of the XTE-60 project area. This actively operated MM project involves the rehabilitation of existing perimeter embankments and the installation of four variable crest weirs (presumably also fitted with flapgated culverts). The project area would become a semi-impoundment within which water level drawdowns to expose eroded surface could be undertaken.

Project **XTE-55** encompasses a 22,000-acre previously unmanaged brackish marsh area that exhibited relatively high internal marsh loss. The bulk of the loss occurred during the 1958-1983 time frame in close association with petroleum extraction canals constructed during the 1930's to 1974 time frames. The canal system's effect on altering the hydrology is suspected of being part of the historical internal marsh loss problem. Relatively high internal marsh losses are expected to continue. To mimic historic conditions this passively operated HR project involves the installation of water control structures along the northern and eastern boundaries. The structures would allow control of fresh water inputs and reduce inputs from the HNC to overflows only. Because no structures or work would occur along the southern boundary, the project area would remain an open system that exhibited an unmuted tidal signal.

Project **XTE-59** encompasses a 4,544-acre parcel of previously unmanaged fresh/intermediate/brackish marsh types that has exhibited interior marsh loss and shoreline erosion. The marsh loss occurred during the 1930's-1983 time frames. Two "nodes" are evident. One node occurs in the extreme northern portion, in association with a petroleum extraction canal excavated during the 1958-1974 time frame. The other node occurs during the 1958-1974 time frame in the form of a band (with an east-west orientation) at what could be the southern limit of the project's area of effect. The recorded shoreline erosion occurred along the souther rim of Lake de Cade, primarily during the 1930-1958 time frame. To mimic historic conditions this passively operated HR project involves work along the western and northern perimeters. A structure would be installed in the southern Lake de Cade shoreline to allow for fresher water introductions. Another structure would be installed to relive an impoundment situation in the northern-most portion of the project area. Elsewhere, the project area would remain open and would continue to exhibit an unmuted tidal signal.

The **PTE-22/24** project areas (collectively a 5,400-acre brackish/saline marsh area) encompass areas that have exhibited primarily man-made and some internal marsh loss. Each area is influenced by a canal that is open to the Gulf.

To mimic historic conditions this passively operated HR project involves to construction of solid plugs in the canals near the Gulf, some backfilling and the installation of solid plugs at more inland locations in the canals. The man-made direct hydrologic link to the Gulf would be closed to mimic some unstipulated historic conditions. Additinally, marsh would be created on backfilled areas.

Q.5. **Profiles of Teche-Vermilion Basin CWPPRA HM Projects**

Overview of Basin Land Loss

Shoreline erosion rates are likely to remain relatively high or even increase along the shoreline where erosion is now occurring. The effects of altered hydrology will likely increase the potential for accelerated loss rates in the marshes north and south of the Intracoastal Canal east of Intracoastal City, and portions of the Paul J. Rainey Wildlife Refuge. Additional future losses may occur near Lake Cock, Hammock Lake, and near Lakes Tom and Sand (Marsh Island) due to shoreline breaching. Altered surface hydrology appears to be a reason to suspected accelerated interior marsh losses between Mud Lake and Bayou Sale including the area near Horseshoe Bend.

Summary of the Basins's Candidate CWPPRA HM Projects

Five CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 6; Tables 26, 32, and 35; Figure 24). One (30,000 acres) has already been permitted. Collectively, the remaining four projects encompass 14,643 acres. Of that total, 2,181 previously unmanaged acres could be brought under management, the management of 12,062 acres could be sustained and a management capability could be reacquired over 400 acres.

All five project areas exhibit shoreline erosion throughout most or all of the period of record. One project includes reduction of internal marsh losment. Thus, the frequency, direction and duration of communications this internal, managed area would retain with the unmanaged estuary could be increased to what was allowed to occur through additional water control structures, depending upon the operational plan (unspecified), and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment.

See also main text at 5.2.1.5.

Individual CWPPRA HM Project Profiles

Project **TV-1** encompasses a 2,181-acre brackish marsh area

that has exhibited relatively high shoreline erosion throughout the period of record. Very little internal marsh loss was recorded. Wind-driven waves from prevailing winds is the suspected reason for the erosion. Shoreline erosion is expected to continue. Any internal marsh loss that may have occurred was not be detectable with aerial photography of GIS. To mimic historic conditions this actively operated hydrologic restoration project involves installing a solid plug at the mouth of a man-made canal and cutting gaps in one canal embankment to facilitate surface water movement, the installation of two rip-rap plugs in a pipeline canal and the installation of a fixed-crest weir and culvert at the canal end near where a flap-gate would be installed in a bayou. To arrest shoreline erosion, the exposed shoreline would be armored. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **TV-4** encompasses a 30,000-acre fresh marsh area that has exhibited relatively high shoreline and interior marsh loss.
The shoreline losses have occurred throughout the period of record and are expected to continue due to wind-driven waves. Nearly all of the recorded internal marsh loss occurred during the 1930's-1974 time frames. During those same time frames petroleum extraction canal systems were excavated. Those canal systems are suspected of locally retarding surface drainage as well as locally increasing tidal amplitude and scour. Those conditions may persist. To mimic historic conditions this actively operated hydrologic restoration project involves the installation of perimeter structures consisting of low level rock weirs at major waterway opening along the Cote Blanche Bays, and several one-way flapgated culverts to control introductions of fresher water and sediments. A shoreline rock bulkhead would be installed to stop shoreline erosion at critical locations. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures or marsh. Freshwater and sediment inputs from the Gulf Intracoastal Waterway would be reduced to pulsed, point-source inputs rather than what they are (i.e., ambient hydrologic happenings through breaches in canal embankments).

Project **TV-5/7** encompasses 6,697-acre brackish marsh area that has exhibited a high rate of shoreline erosion (bay and interior lakes) throughout the period of record. Losses

from the excavation of petroleum extraction canals during the 1958-1974 time frame were also recorded. Interior marsh losses have been reported, attributed to the hydrologic effects of the canals, but may be occurring at rates that are,difficult to detect. To mimic historic conditions this passively operated hydrologic restoration project involves rebuilding/armoring portions of the eroded bay-front shoreline, plugging the mouths of the canals and gapping canal embankments to restore internal surface flow patterns. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary at the structures would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures. The targeted marsh would remain open to undampened tidal influences via a natural bayou.

Project **TV-8** encompasses a 400-acre brackish marsh area that has exhibited high shoreline erosion throughout the period of record due to wind-driven wave action. That situation is expected to continue. A weir once controlled the hydrology of the marsh but it is no longer functional. To mimic historic conditions this actively operated hydrologic restoration project involves replacing the old weir with a variable-crest weir fitted with a vertical slot and the construction of a rock breakwater. The hydrology of the area will be returned to a managed condition. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures.

Project **PTV-10/XTV-25** encompasses a 5,365-acre currently managed parcel of intermediate marsh that has exhibited exposed shoreline and canal bank erosion over the period of record. The conceptual plan calls for the use of hard structures and shoreline protection measures.

Q.6. **Deltas Basins/Regional Summary**

See main text at 5.2.1.6.

Q.7. **Profiles of Mermentau Basin CWPPRA HM Projects**

Overview of Basin Land Loss

Relatively high shoreline erosion rates are likely to continue along the Gulf and along the shorelines of Grand, White, Sweet and Latina Lakes, as well as Lakes Cullicon and Misere. Altered surface hydrology is suspected to be the reason it's likely losses will continue at relatively high rates in the marshes north of White Lake, south of Pecan

Island, near Secon Lake and east of Louisiana Highway 27 near the Intracoastal Waterway.

Shoreline breaches due to wave action could lead to accelerated erosion of marshes near Clear and Catfish Lakes and at several places along the Gulf shoreline.

Altered surface hydrology would be the reason marshes could erode more rapidly in the foreseeable future southeast of Pecan island, due east of White Lake, south of Lake Misere and between White Lake and Freshwater Bayou (south of the Gulf Intracoastal Waterway).

Basin CWPPRA HM Projects

Ten CWPPRA HM projects were assumed to be viable candidates for future implementation (Plate 7; Tables 27, 33 and 35; Figure 24). However, one (PME-14) was permitted and one permit (ME-2) was denied. Collectively, the eight encompass 41,140 acres. Of that total, 14,381 previously unmanaged acres could be brought under management, the management capability would be reacquired on 12,250 acres and the management capability would be sustained on 14,509 acres.

All the projects are multi-purposed. Three have control of loss, either internal (n = 2) or shoreline (n = 1), as at least one purpose. The other projects all share the goal of enhancing biological productivity of the targeted areas. All the project areas have exhibited marsh losses. The extent of those losses and the time frames in which the losses were most extensive varied. Losses in some areas have been recorded as recent as the 1983-1990 time frame. HR would be the management option of choice for seven of the eight project areas, collectively encompassing 33,840 acres. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. One project would sustain an active MM effort encompassing 7300 acres. HR is apparently perceived to be implementable over all four marsh types, whether or not the management would be active or passive, regardless of the purposes of the projects, and regardless of the size of the project areas.

For the most part, the projects exhibit a disconnected spatial relationship to one another (Plate 7). However, it is possible, even probable, that the projects clustered south of Grand Lake and astrattle the Mermentau River may be interdependent to a degree related to river hydrology. Whatsmore, the proximity of those three projects could have interactive effects with an upstream previously permitted project. Much of the western and central portions of the Chenier Sub-basin have been managed for years. In contrast the marshes/water in the southeastern and eastern portions

of that sub-basin represent that bulk of the remaining unmanaged marsh/water in the sub-basin. Projects XME-46 and ME-4 collectively target much of that marsh and could also be expected to have interactive effects with adjoining permitted project areas. Elsewhere, the impacts and effects of the other four projects are more likely to occur within or in the immediate vicinity of each project area.

See main text at 5.2.2.1.

Individual CWPPRA HM Project Profiles

Projects **PME-14**, **PME-15**, **XME-40**, **XME-45**, and **XME-46** collectively encompass all four marsh types and areas that have exhibited historic marsh losses. Interior marsh losses in the areas encompassed by PME-14 (sustain current management), XME-46 (reacquire management capability) were characterized as relatively high. Interior marsh losses in the areas encompassed by PME-15 (reacquire management capability), XME-40 (sustain current management) and XME-45 (sustain on-going management) were characterized as moderate. Most of the losses in XME-45 occurred since 1983. Most of the losses in PME-14 occurred during the 1958-1974 time frame. Most of the losses in PME-15, XME-40 and XME-46 occurred during the 1930's to 1974 time frame. Any losses that may have occurred since then in those five areas have generally not been measurable. All five projects involve the installation of water control structures that would upgrade the existing structures and increase/perpetuate the potential to actively manipulate water levels in these managed areas.

Project **PME-16** encompasses a 7,300-acre fresh/intermediate marsh area that has exhibited fairly constant but not extensive historic interior marsh loss during the 1930's-1983 time frames. The targeted marsh area is currently managed by a distant structure. This actively operated MM plan would likely involve the installation of variable-crest weirs fitted with flapgated culverts. The hydrology of this project area is already influenced by the operation of several water control structures. The frequency, direction and duration of water movements through the project's structures would mirror the effects of those other structures. Therefore, the communication this managed area would retain with the unmanaged estuary would be reduced to what would/could occur whenever tidal or flood water levels overtopped the structures, the marsh and/or any perimeter embankments.

Project **ME-4** encompasses 14,381 previously unmanaged acres of fresh and intermediate marsh types that have exhibited internal marsh losses mostly during the 1956-1974 time

frame. Additional losses were recorded during the 1974-1983 time period. The recorded losses are attributed to increased tidal exchange and salinity increases associated with the Freshwater Bayou Canal combined with retention of additional fresh water inputs from the Grand and White Lakes system to the west. To mimic historic conditions this actively operated HR project involves the installation of 10,000 feet of rip-rap to stabilize the western bank of the Freshwater Bayou Canal and the installation and operation of gated water control structures along the western perimeter.

Project **XME-43** encompasses 1,750 acres of shallow open water and fresh marsh in a formerly managed area that exhibited nearly the loss of the entire wetland plant community during the 1974-1983 time frame. An unattended-to levee failure, and elevated salinity levels, are the suspect reasons for the recorded marsh loss. To mimic historic conditions this HR project involves 10,000 feet of levee rehabilitation.

Q.8. **Profiles of Calcasieu-Sabine Basin CWPPRA HM Projects**

Overview of Basin Land Loss

This basin was studied by the United States Department of Agriculture, Soil Conservation Service (now the National Resource Conservation Service) (1993). To facilitate the study, the entire basin was conceptually partitioned into individual management units. Management recommendations were made for each unit. The CWPPRA HR and MM plans mirror those study findings. Therefore, the reader is urged to refer to the cited publication for any additional detailed information.

Damages to marshes from hurricanes and flooding events during the period 1955 to 1974 have been noteworthy, especially in marsh along the southern rim of the western part of the basin and in the vicinity of Mudd Lake. Wave and tidal action are suspected of combining to gouge holes in the marsh surface. Water with stressful or toxic levels of salinity that were forced inland by the storms didn't drain off fast enough to avoid damaging the more susceptible marsh plants. Over the years, erosion of the shorelines of the resulting open water areas continued.

Relatively high Gulf shoreline erosion rates are expected to continue. The continuing effects of altered surface hydrology are suspected of being why the mashes between Back Ridge and the south shore of Calcasieu Lake, the West Cove shoreline, the marshes between Mud Lake and the Calcasieu Ship Channel, and the marshes between Hamilton Lake and Starks south Canal will continue to exhibit relatively high

erosion rates.

Basin CWPPRA HM Projects

Forty-three CWPPRA HM projects are assumed to be viable candidates for future implementation (Plate 8; Tables 28, 34 and 35; Figure 24). Several have been previously permitted but even more represent even more site-specific management efforts nested within the footprints of other larger candidate management projects. Thus, 31 individual projects were identified. Collectively, they encompass 245,434 acres. Of that total, 150,234 previously unmanaged acres could be brought under management and the management capability would be sustained on 95,200 acres.

Much more than half of the projects are intent upon improving conditions for aquatic plant growth and/or prolonging the existence of remaining marsh vegetation in targeted areas. Some also have as a goal control of wind-induced wave caused erosion of shorelines/remaining marsh within targeted areas. Areas that haven't exhibited some marsh losses during the period of record would represent a deviation from the norm. Nearly all of those areas are in the southwestern portion of the western sub-basin. The vast majority of the recorded marsh losses occurred during the 1956-1974 time. Losses of interior marshes during the 1974 - 1990 time frames were much more site specific (generally east and immediately northwest of Calcasieu Lake and in the central portion of the western sub-basin).

HR would be the management option of choice for most of the candidate projects, collectively encompassing 259,354 acres. None of the HR projects has yet stipulated the point in time that represents the historic situation to be emulated. MM would be the management option of choice for 115,695 acres, most of which reestablish former or prolong on-going management efforts. MM and HR are apparently perceived to be implementable over all marsh types, whether of not the management would be active or passive, regardless of the size of the management area and regardless of when the loss occurred.

Nowhere else in the coastal zone and nowhere on such a scale is there such an extensive effort to bring nearly every acre of a sub-basin under some form of HM. As a result, the tidal signals within every one of the candidate managed areas would be only partially reflective of the rhythm and dynamics of the tidal signal in the unmanaged portion of the estuary. In some areas, there may be little if any tidal signal, given the nesting of projects.

In this basin more so than any other, some projects may be

more influential than others. Projects located along and targeting perimeter marshes should be assumed to have secondary effects on more internal marsh/water areas. An accurate assessment of the hydrologic interactions/inter-dependencies would be most insightful for more precisely forecasting impacts and effects to significant attributes.

See main text at 5.2.2.2.

Individual Calcasieu-Sabine Basin HM CWPPRA Projects

East of Calcasieu Lake

Project **PCS-25** encompasses a 650-acre parcel of formerly managed fresh and intermediate marsh types that has exhibited relatively high marsh loss, especially during the 1958-1974 time frame. The affects from shoreline erosion, canals and subsidence are suspected of being the major historic land loss problems. Losses in the project area are not expected to accelerate or remain high. To mimic historic conditions this actively operated HR project would involve the installation of new flapgated culverts, installation of a solid plug in a shoreline breach and freshwater introductions.

Project **CS-14** is estimated to have an area of influence encompassing about 1,186 acres of currently managed brackish marsh within a previously permitted project area that encompasses a portion of the Sabine National Wildlife Refuge. The likely area of effect has exhibited relatively high marsh loss throughout the period of record. This project involves the installation of a variable crest, slotted weir fitted with flapgated culverts and the excavation of a small canal to facilitate water exchange with Calcasieu Lake. The intent of the project is to better achieve the management goals of the Cameron-Creole project. This project would not bring any new marsh under management.

Project **CS-10** encompasses a 1,462-acre previously managed brackish marsh that has exhibited relatively high marsh loss, especially during the 1958-1983 time frames. Future loss is not expected to remain high or accelerate. This actively operated MM plan would involve installation of a rock weir in a bayou, variable-crest weirs fitted with flapgated culverts, rehabilitation of a portion of the perimeter levee to a height of three feet and cutting gaps in an internal embankment. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter

embankments.

West of Calcasieu Lake

Southwest Calcasieu Lake

Project **SO-7** encompasses a 2,400-acre parcel of previously unmanaged perimeter brackish marsh that comprises a portion of the western rim of Calcasieu Lake. The area has evidenced extensive internal marsh loss nearly all of which occurred during the 1956-1974 time period. Hurricane damage has been implicated for that loss. Increased tidal exchange and elevated salinity levels are implicated as current problems. This active MM plan entails the installation of rock weirs and water control structures.

Project **XCS-48(SO-8)** encompasses a 12,600-acre previously managed area characterized as brackish marsh. Project **PCS-12/18** encompasses a 7,560-acre portion of the XCS-48(SO-8) project area and is characterized as containing the brackish marsh type. The XCS-48(SO-8) project area has exhibited marsh loss, especially during the 1958-1983 time frames. The effects of increased tidal amplitude and saltwater, related to the Calcasieu Ship Channel, the effects of canals and the effects of storms and several other high water events are all suspected of contributing to the historic marsh loss. Losses in the project area may remain high and may accelerate. To mimic historic conditions these passively operated HR projects would, at a minimum involve the installation of a large weir (design unspecified) in a natural bayou. Implementation of PCS-12/18 would involve the installation of a second weir (design unspecified) in another natural bayou. Under the more constrictive PCS-12/18 project scenario, the frequency, direction and duration of communications even the larger XCS-48(SO-8) project area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures if rock weirs are installed and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **XCS-48(SO-5)** encompasses a 12,007-acre currently managed intermediate/brackish marsh that has exhibited relatively high land loss, nearly all of which occurred during the 1958-1974 time frame. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, and possibly storms, are suspected of being part of the historic land loss problem. Losses in the project area are not expected to accelerate. This project would not bring any marsh under management for the first time. However, to mimic historic conditions this actively operated HR project would involve the addition of a

variable crest weir to an existing structure.

Project **PCS-24** encompasses a 8,100-acre formerly managed brackish marsh that has exhibited relatively high land loss, nearly all of which occurred during the 1958-1983 time frames. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, canals, unintended modifications of tidal and salinity regimes and possibly storms, are suspected of being part of the historic land loss problem. Losses in the project area may remain high or even accelerate. This project would not bring any marsh under management for the first time. This actively operated MM plan involves perimeter work consisting of the installation of several variable-crest slotted weirs fitted with flapgated culverts, earthen plugs, ant the restoration of nearly a mile of existing embankment.

West-Central Calcasieu Lake

Project **XCS-44** encompasses a 4,390-acre brackish marsh that was influenced by a plug and has exhibited relatively high land loss, nearly all of which occurred during the 1958-1974 time frame. The effects of canal construction on tidal fluctuations and a salinity regime that reflects the proximity of the project area to the Calcasieu Ship Channel are suspected of being part of the historic land loss problem. Losses in the project area may remain high or even accelerate. To mimic historic conditions this passively managed HR plans involves the installation of a solid earthen plug at the mouth of the West Cove Canal near the junction with the ship channel. The frequency, direction and duration of communications the northern part of this managed area would retain with the unmanaged estuary would be only little changed as several other exchange points still exist along several thousand feet of interface between the marsh and the ship channel. The frequency, direction and duration of communications the southern part of this managed area would retain with the unmanaged area could be quite different. The canal that would be plugged intersects a natural bayou that undoubtedly effects the hydrology of this southern area. The operation of a Sabine National Wildlife Refuge water control structure could also be affected. The canal that would be plugged is the direct hydrologic link between the structure and the ship channel and salt water.

Project **XCS-47/48i,j,k,p** would affect an estimated 42,247 acres of formerly and currently managed interior intermediate and brackish marsh types that have exhibited a relatively high marsh loss. Most of the recorded loss occurred in the northeastern one-third of the project area and nearly all during the 1958-1974 time frame. The

targeted marsh once was a closed, managed marsh system. The perimeter structures were breached years ago and were not completely repaired. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, canals, the effects of tidal action and salt water in the managed area following breaching of the perimeter structures, and possibly storms, are suspected of being part of the historic land loss problem. The targeted marsh became a controlled hydrologic system again with the recent installation of the Rycade Canal structure (see project CS-2). This actively operated HR/MM project involves the replacement and upgrade of three sets of existing but undercapacity perimeter water control structures. The new structures would allow for greater control of water levels to include water level lowerings.

Project **XCS-46** would effect an estimated 12,012 acres of formerly and currently managed intermediate/brackish marsh on the Sabine National Wildlife Refuge that has exhibited relatively high marsh loss, especially during the 1958-1974 time frame. The affected marsh would be a part of the western portion of the XCS-47/48i,j,k project area. To mimic the historic condition, this passively operated HR project would involve the installation of a water control structure (design unspecified) in the North Starks Canal. The structure would serve to reduce/eliminate the breach the canal created in the natural boundary between the Calcasieu and Sabine basins. The impacts would be to reduce/eliminate any direct exchange between the two basins via the man-made canal, thereby enhancing the operational capability of the XCS-47/48i,j,k project structures.

Projects **XCS-48(SA-1, SA-1a, SA-1b, and SA-2)** collectively encompass 18,749 acres. Collectively, all four marsh types are represented. All four area are part of the Sabine National Wildlife Refuge and have been managed for years or still are managed. Water levels in SA-1, SA-1a and SA-1b are controlled with variable crest weirs, and augmented with pumps in SA-1a and SA-1b. Water levels in the SA-1 are currently influenced by the Rycade Canal structure (project CS-2) and would also be influenced by the XCS-46 structure in North Starks Canal. Water levels in SA-1a and SA-1b are independently controlled but because they are gravity operated, they are influenced by the Rycade Canal and other refuge perimeter structures. SA-2's perimeter embankment has been breached for several years allowing water level control to be accomplished with the structures that would be replaced by project XCS-47/48i,j,k,p. Project area SA-2 has exhibited very little loss during the period of record. Project area SA-1 exhibited loss throughout the period of record but localized losses were recorded in the extreme southwestern portion during the 1930-1954 time frame and

more generalized losses throughout the area were recorded during the 1958-1974 time frame. Project areas SA-1a and SA-1b exhibited general loss that occurred principally during the 1958-1983 time frames. Losses were attributed to several causes, including the adverse effects of slow-to-drain saline waters introduced into these areas by hurricanes in 1957 and again in 1961, as well as intentional efforts to open up the marsh as part of the management program. Project SA-01 is classified as a nutrient trapping project and water levels would mimic a managed condition through the manipulation of the Rycade Canal and other refuge perimeter structures. To mimic a historic condition in the other three project areas these actively managed HR projects would involve the installation of additional structures with which to more site specifically manage water levels and shunt fresher water into the SA-1 project area (SA-1a and SA-1b) and maintenance of the existing perimeter embankment (SA-2). The frequency, direction and duration of communications these areas would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankments.

Project **XCS-48(SA-10)** encompasses a 4,600-acre parcel of formerly unmanaged brackish and saline marsh types that comprise a portion of the western rim of Calcasieu Lake and is part of the Sabine National Wildlife Refuge. The targeted marsh has exhibited extensive internal marsh losses. Those losses occurred almost entirely during the 1956-1974 time period. To mimic historic hydrologic conditions this project would entail placement of a plug in a man-made canal that communicates directly with water in the Calcasieu Shipchannel as well as the rehabilitation/upgrade of existing structures that control the hydrology of an upstream area.

Northwest Calcasieu Lake

Project **CS-9** would effect 2,800 acres of brackish marsh of previously unmanaged marsh that has exhibited relatively high loss, the majority of which occurred during the 1958-1974 time frame. The Alkali Ditch was constructed during the 1930-1954 time frame to provide access to petroleum extraction operations. Increased tidal dynamics and salinity associated with subsequent deepenings of the Calcasieu Ship Channel are suspected of being part of the historic loss problem. This actively operated MM project would involve the construction of a perimeter embankment system inclusive of several variable crest slotted weirs fitted with flapgated culverts (to create the opportunity to conduct water level drawdowns), a fixed-crest weir with a

boat bay and a freshwater introduction structure. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankments.

Project **XCS-53** encompasses 2,500 acres, which includes the old Brown Lake and adjoin brackish marsh. Relatively high historic loss was recorded in the project area especially during the 1958-1974 time frame. The Alkali Ditch was constructed during the 1930-1954 time frame to provide access to petroleum extraction operations. Increased tidal dynamics and salinity associated with subsequent deepenings of the Calcasieu Ship Channel are suspected of being part of the historic loss problem. To mimic historic condition this passively operated HR project would involve the construction of a weir (with a boat bay) across the Alkali Ditch where it intersects with the Gulf Intracoastal Waterway. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to occurred over the weir crest and would/could occur during those occasions when tides rose to levels that overtopped the marsh. Additionally, this structure would influence the hydrology of the CS-5 project area until that project was completed. The Rycade Canal structure, and the area that it influences, would also be influenced by the Alkali Ditch structure.

Projects **CS-8/XCS-48(NO-2, 2a, 4 and 5)** collectively encompass 13,787 acres of intermediate/brackish marsh. All four areas have exhibited relatively high historic loss, almost exclusively during the 1958-1974 time frame. Only NO-5 would constitute first time management. The effects of canal construction on tidal fluctuations, a salinity regime that reflects the proximity of the project area to the Calcasieu Ship Channel, and possibly the effects of storms are suspected of being part of the historic land loss problem. Losses in these project areas may remain high or even accelerate. Areas NO-2 and NO-4 have been under private management for several years. They would bring no new marsh under management. To continue the current management capability of NO-4 and to upgrade the management capability of NO-2, both actively operated MM areas, would involve maintenance of the existing perimeter embankments, some structure upgrades and for NO-2 installation of a freshwater input system. To reacquire management capability of NO-2a, this actively operated MM plan would involve the reconstruction of the perimeter embankment fitted and the installation of a variable-crest, slotted weir and flapgated culverts to reestablish a semi-impoundment. To mimic

historic conditions in NO-5, a formerly unmanaged area, this passively operated HR plan would involve the installation of water control structures (design unspecified), plugging man-made canals and gapping of the associated canal embankments, as well as some marsh creation with dredged material and vegetative plantings. Depending upon the final operational plans, the hydrology of each area may not be very similar. However, the hydrology of all four areas would be influenced by the Alkali Ditch structure but in different ways. The frequency, direction and duration of communications all four project areas would retain with the unmanaged estuary would be reduced to whatever was presented to and allowed to pass through the project structures after first being influenced by the Alkali Ditch structure and what would/could occur when water depths overtopped the structures and /or the perimeter embankments.

Project **CS-2** encompasses a 10,000-acre portion of intermediate/brackish marsh. However, other projects will be implemented which would reduce to 4,600 the number of acres ultimately influenced by this structure. Historic marsh losses in the project area have been characterized previously (e.g., see project XCS-48(SA-1). The project has already been completed. To mimic historic conditions this actively operated HR structure involved the construction of a water control structure fitted with seven culverts and the installation of three culverts under an oil field road to the west. Until the Alkali Ditch structure is installed, this Rycade Canal structure functions as a perimeter affecting the areas described in **XCS-47/48i,j,k,p**, and **XCS-48(SA-1, SA-1a, SA-1b, and SA-2)**. With the installation of the Alkali Ditch structure, this CS-2 - Rycade Canal structure would revert to an internal structure. The hydrologic impact would be to diminish the frequency, direction and duration of communication more internal marshes and included project areas would retain with the surrounding unmanaged estuary.

Project **XCS-48(NO-8)** is 4,600-acre currently managed parcel that encompasses mostly shallow open water and brackish marsh. This historic fresh marsh area has exhibited relatively high marsh loss (see projects **XCS-47/48i,j,k,p**, and **XCS-48(SA-1, SA-1a, SA-1b, and SA-2)**. Although classified as a CWPPRA sediment trapping implementation of this project would not bring any new marsh under management but would involve the passive operation of variable-crest weirs, maintenance of the perimeter embankment, vegetative plantings and use of wave stilling/sediment trapping devices. The frequency, direction and duration of communications this management area would retain with the unmanaged estuary would be reduced to whatever was presented to and allowed to pass through the project structures after

first being influenced by the Alkali Ditch structure and then by the Rycade Canal structure, as well as what would/could occur when water depths overtopped the structures and/or the perimeter embankments.

Project **PCS-14** targets a 2,500-acre parcel. The targeted area is much of the marsh and open water described under project XCS-47/48i,j,k,p, and XCS-48(NO-5). To mimic historic conditions in those interior marshes this project would involve the installation of a weir with a boat bay in Kelso Bayou, a natural waterway, easterly from Louisiana Highway 27.
The **XCS-48(NO-3)** project area has been continuously managed for more than 30 years, apparently with the assistance of pumps. During the 1960's through a portion of the 1980's the area was managed as a cattle pasture. More recently, the area has been and is managed for waterfowl and freshwater fisheries. This project involves maintaining the existing management capability of the intermediate marsh. No new marsh would be brought under management. The frequency, direction and duration of communications the targeted interior marshes would retain with the unmanaged estuary would remain whatever passed into the area from pumping, what ever was allowed to pass through the structures and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

Project **CS-5a/12** is a 30,050-acre parcel that encompasses several management units and fresh, intermediate and brackish marsh types. This large scale, passively operated HR project proposes to introduce fresh water into an area that consists of an integrated collection of individually managed marshes (project areas NO-13 through NO-20). The passive and active management operations of the several project areas would attempt to take advantage of the fresh water to mimic historic marsh conditions. Implementation of the several individual projects would involve the rehabilitation and/or upgrade of existing as well as the installation of many new structures.

Project areas **XCS/48-14, 15 and 17** are 4,200, 900 and 2,950-acre parcels, respectively, encompass both fresh and intermediate marsh vegetation and open water that has never been previously managed. These historic intermediate (NO-14) and fresh/intermediate marshes (NO-15, 17) have exhibited historic marsh loss, most of which occurred during the 1956-1978 time frame in NO-14 and NO-17 and during the 1968-1984 time frame in NO-15. Exposure to marine processes (from the Calcasieu Ship channel via the Gulf Intracoastal Waterway) is suspected of being part of the historic problem as may be unintentional partial

impoundment. Since then, the marshes have appeared to remain stable.

NO-14 would be a passively operated MM area. To bring this marsh under management for the first time would involve the installation of a rock weir in each of the two natural tributaries of Black Bayou that drain the project area, apparently creating a "permeable" (because of the hydrologic characteristics of the rock weir) semi-impoundment. The frequency, direction and duration of communications this interior marsh in a managed configuration would retain with the unmanaged estuary would be reduced to whatever was allowed to move from Black bayou and enter the area through the structures and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

NO-15 and **NO-17** would be passively operated HR projects. To mimic historic conditions in project area NO-15 a structure (possibly solid plugs) would be placed in each of the two natural waterways and a structure of unspecified design would be placed in a man-made canal. The frequency, direction and duration of communications this marsh in a managed configuration would retain with the unmanaged estuary would be reduced to whatever exchange occurred between Black Bayou and the area from the south and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments. To mimic historic conditions in project area NO-17 some of the existing embankments would be repaired, a rock weir would be installed in each of two breaches in a man-made canal embankment, and a flapgated culvert would be installed under a road (that is part of the southern boundary) to discharge (only) into the immediately adjacent unit (NO-18). The man-made canal is a hydrologic "bridge" between the upper portion of Black Bayou and the Gulf Intracoastal Waterway. Under another project scenario, the opening of this canal would be closed, resulting in the two weirs being located near the extreme northern end of a dead end canal that is itself located at the extreme northern end of a natural bayou. Control of the water level in NO-17 would also be affected by the operation of the flapgated culvert on the southern boundary. The frequency, direction and duration of communications NO-17 would retain in a "permeable" semi-impounded configuration with the Black Bayou and the unmanaged portion of the system would be reduced to what would be allowed to occur through/over the rock weirs and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

Northeast Sabine Lake

Project **NO-13** encompasses a 4,600-acre previously managed parcel of predominantly open water and the intermediate marsh type. This historic fresh/intermediate marsh has exhibited marsh loss, nearly all of which occurred during the 1956-1978 time frame. The area is bordered on all four sides by man-made features but breaches in the northern and western boundaries may have occurred over time. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic problem. To mimic historic conditions (i.e., fresh marsh) this passively operated HR project would involve the installation of a solid plugs as well as structure (design unspecified) substitutions in the perimeter embankment system apparently restoring this area to a semi-impounded condition. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through/over the crest of the new structures and would/could occur during those occasions when tides rose to levels that overtopped the marsh.

Project **NO-14a** encompasses a 3,500-acre parcel of previously unmanaged intermediate/brackish marsh types and open water. This historic intermediate marsh has exhibited relatively little loss. Rather, it has exhibited a change in type in the more western portion to a more brackish marsh type. The area is bordered on three side by man-made features but has always had free exchange with Black Bayou and the south prong of Black Bayou along the entire western boundary. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic problem. To mimic historic conditions (i.e., fresh to intermediate marsh) this passively operated HR project would involve the installation of a rock weir in two of the several natural tributaries of the Black Bayou system that drain the project area. The frequency, duration and direction of communications this managed area would retain with Black Bayou and the unmanaged portion of the Black estuary would be reduced to what occurred through the other unaltered tributary connections, what occurred over the weir crests and would/could occur during those occasions when tides rose to levels that overtopped the marsh.

Project area **XCS-48(NO-18)** encompasses a 4,800-acre previously unmanaged parcel of the intermediate and brackish marsh types and open water. This historic intermediate marsh has exhibited relatively little loss during the period of record. Rather, it has exhibited a marsh type changes,

most recently to include brackish marsh plant species. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic marsh loss problem. To mimic historic conditions (i.e., fresh/intermediate marsh, inputs from NO-17) this passively operated HR project would involve installing rock liners in most of the locations where the area communicates with Black Bayou and installation of a culvert to provide inputs from XCS-48(NO-19). The frequency, duration and direction of communications this interior managed marsh area would retain with Black Bayou and the unmanaged portion of the system would be little changed.

Project areas **XCS-48(19, 20 and 21)** comprise the down-stream marsh area of the Black Bayou system. Collectively, they encompass 17,952 acres of marsh vegetation and open water.

Project area **XCS-19** encompasses a 10,970-acre formerly unmanaged parcel of intermediate and brackish marsh types and open water. This historic intermediate marsh has exhibited relatively little loss during the period of record. Rather, it has exhibited marsh type changes, most recently to include brackish marsh plant species. The effects of localized salinities and winter droughts are suspected to be part of the historic marsh loss problem. To bring this marsh under management (i.e., passively operated HR) for the first time, historic conditions (i.e., fresh/intermediate marsh) would be mimicked by installing rock weirs in one man-made and several natural tributaries to Black Bayou, installing a solid plug in a man-made canal at the Sabine River {apparently creating a "permeable" (because of the hydrologic characteristics of rock weirs) semi-impoundment} and performing internal work to enhance sediment/nutrient retention. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanaged portion of the system would be reduced to what would occur through the rock weirs and what could/would occur when storm-driven water levels overtopped the natural and man-made embankments.

Project area **XCS-48(NO-20)** encompasses a 1,600-acre parcel of formerly unmanaged intermediate and brackish marsh types and very little open water. This historic brackish marsh has exhibited relatively little loss during the period of record. Rather, it has exhibited a shift towards a fresher marsh type. To bring this marsh under management (i.e., passively operated HR) for the first time, management would focus on converting the existing marsh to a fresh/intermediate mix. That effort would involve the installation of rock weirs in several of the natural tributaries of Black Bayou and assumes that plugging of the

man-made canal called for in XME-48(NO-19) would occur. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanaged portion of the system would be reduced to what would occur through the rock weirs and could/would occur when storm-driven water levels overtopped the structures and the marsh.

Project area **XCS-48(NO-21)** encompasses a 6,650-acre parcel of formerly unmanaged perimeter brackish marsh vegetation type and very little open water. This parcel was historically mapped as grazing land and intermediate marsh has exhibited relatively little loss during the period of record. To bring this intermediate/brackish marsh under management (i.e., passively operated HR) for the first time, management would focus on converting the existing marsh types to the fresh and intermediate marsh types. That effort would involve the installation of rock weirs in several of the natural tributaries of Black Bayou and assumes that plugging of the man-made canal called for in XME-48(NO-19) would occur. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanaged portion of the system would be reduced to what would occur through the rock weirs and what could/would occur when storm-driven water levels overtopped the marsh.

East-central Sabine Lake

Project area **PCS-10** encompasses a 1,680-acre parcel of formerly unmanaged perimeter brackish marsh type and open water. This parcel was historically mapped as fresh/intermediate marsh and has exhibited historic loss and a conversion to the brackish marsh type. Construction of the Sabine River ship channel is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations and collectively causing the recorded marsh loss and type shift. To bring this area under management (i.e., passively operated HR/MM) for the first time would involve the installation of weirs (design unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanaged portion of the system would be reduced to what would occur through/over the weirs and what could/would occur when storm-driven water levels overtopped the marsh.

Project **PCS-11** encompasses a 600-acre parcel of the brackish marsh type and relatively little open water. This parcel was historically mapped as intermediate/brackish marsh and

has exhibited historic loss and a conversion to the brackish marsh type. Construction of the Sabine River ship channel, preceded by the construction of internal canals, is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations and collectively causing the recorded marsh loss and type shift. To bring this area under management (i.e., passively operated HR) for the first time would involve the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the plugs/weirs and what could/would occur when storm-driven water levels overtopped the marsh. These structures correspond to some of the Sabine Lake-front structures called for as design components of proposed projects for XCS-48(SA-5 and 7).

Project areas **XCS-48(SA-3, 4 and 6)** are part of the Sabine National Wildlife Refuge. Activities in the SA-3 and SA-4 areas are not included in this analysis but the descriptions are included for context.

SA-3 is a 26,356-acre internal marsh parcel that was historically a solid fresh marsh. An actively operated managed marsh impoundment since 1951, marsh loss and the appearance of the brackish marsh type have occurred. Marsh losses were characterized as relatively high almost all of which occurred during the 1958-1974 time frame. Some of the losses were intentionally induced by management. However, some marsh loss and marsh type conversion were also attributed to hurricane damages in 1957 and 1961. A three-year water level drawdown in the early 1980's expanded the coverage of submerged and floating aquatic vegetation and emergent marsh vegetation. Maintenance of low water levels is attributed to have prolonged that trend. Wind-induced erosion in shallow water and along shorelines and too high water levels are seen as the likely causes of marsh loss within this managed freshwater impoundment in the future. The proposed action is characterized as a sediment trapping project and would involve internal activates that would be expected to locally enhance sediment retention. However, the proposed plan would also involve installation of new and upgrades of existing perimeter water control structures to increase the ability to manipulate water levels in this impoundment. Implementation of this project would not bring any new marsh under management.

SA-4 is a 13,614-acre unmanaged, unimpounded internal marsh parcel that was historically a predominately fresh marsh with some intermediate marsh type and very little open

water. Historic marsh losses in this internal parcel were characterized as relatively high and occurred almost entirely during the 1958-1974 time frame. The effects of the Calcasieu Ship Channel on water levels and salinity regimes were identified as suspected reason for part of the marsh loss problem. Hurricanes were not identified as source of marsh loss or damage. Wind-induced erosion in shallow water and along shorelines are seen as the likely causes of marsh loss within this managed freshwater impoundment in the future.

SA-6 is a 7,418-acre unmanaged, unimpounded internal marsh parcel that was historically a solid fresh marsh. Historic marsh losses in this internal parcel were characterized as relatively high and occurred almost entirely during the 1958-1974 time frame, but more exactly between the mid-1950's and the late 1960's. The effects of the Calcasieu and Sabine Ship Channels on water levels and salinity regimes were identified as suspected reasons for part of the marsh loss problem. Hurricanes were not identified as source of marsh loss or damage. A shift towards a more intermediate marsh type has apparently occurred and emergent marsh is reported to have reappeared in some portions during the 1980's. Wind-induced erosion in shallow water and along shorelines and the transport of mobilized sediments through breaks in embankments into adjoin man-made canals are seen as the likely causes of marsh loss within this parcel.

Project areas SA-4 and SA-6 historically could have been influenced by both Black Bayou (to the north and west) as well as Johnson's Bayou (to the west southwest). However, the network of man-made canals has accelerated water movement and possibly even rerouted water movements unintentionally. Water moves to and from these two internal marsh parcels via those man-made waterways. Thus, management actions that affect the frequency, direction and duration of water movements within the man-made canals that communicate with these two internal marsh parcels will also affect the hydrology of the parcels as well. In addition to the installation of some structures (e.g., rock weirs) to site-specifically amend the hydrology of the targeted marshes, actions taken to amend the hydrology of the man-made waterways for other project ares with also affect SA-5 and SA-6. And that expectation was noted and has been factored in as part of the management expectations for these two internal marsh areas. Thus, the frequency, direction and duration of communications these two internal parcels would retain with the unmanaged estuary would be reduced to what was allowed to occur through/over the water control structures located elsewhere as well as what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped

the marsh.

Project area **XCS-48(SA-5)** encompasses a 26,378-acre previously unmanaged parcel of brackish marsh and open water that is also part of the Sabine National Wildlife Refuge. This parcel was historically mapped as fresh and intermediate marsh with little open water but has exhibited historic marsh loss characterized as relatively high, most of which occurred during the 1958-1974 time frame. More recently, an increase in the amount of the brackish marsh type vegetation, accompanied by the reappearance of emergent vegetation at some sites, was reported. Construction of the Calcasieu River and Sabine River ship channels, preceded by the excavation of internal canals and the construction of cattle walkways, is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations, thereby collectively causing the recorded marsh loss and marsh type changes. More recently, an increase in the amount of the brackish marsh type vegetation as well as the reappearance of emergent vegetation in some areas was reported. To bring this area under management (i.e., passively operated HR) for the first time to mimic a historic condition would involve perimeter structure work to include the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system (see Project PCS-11), the installation of operable water control structures and the plugging of man-made waterways. Collectively, the proposed work may convert this area to a semi-impounded area. If not, the frequency, duration and direction of communications this newly managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the plugs/weirs, any stabilized breaches that communicate with the internal canal system, and what could/would occur when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SA-7)** encompasses a 6,286-acre previously unmanaged parcel of brackish marsh and open water that is also part of the Sabine National Wildlife Refuge. This parcel was historically mapped as intermediate and brackish marsh with little open water but has exhibited historic marsh loss characterized as relatively high, most of which occurred during the 1958-1974 time frame, more exactly during the 1950's-1960's time frame. Even more recently, an increase in the amount of the brackish marsh type vegetation, accompanied by the reappearance of emergent vegetation at some sites, was reported. Construction of the Calcasieu River and Sabine River ship channels, preceded by the excavation of internal canals and creation of embankments, are suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of

increasing water level fluctuations and contributing to waterlogging of the soils, thereby collectively causing the recorded marsh loss and marsh type changes. More recently, an increase in the amount of the brackish marsh type vegetation as well as the reappearance of emergent vegetation in some areas was reported. To apparently bring this area under management (i.e., actively operated HR) for the first time to mimic a historic condition would involve perimeter structure work to include the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system (see Project PCS-11), the installation of operable water control structures and the plugging of man-made waterways. The proposed work may convert this area to a semi-impounded area. If not, the frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the perimeter plugs/weirs, any stabilized breaches (in a portion of perimeter embankment) that communicate with the internal canal system, and what could/would occur when storm-driven water levels overtopped the structures, embankment and marsh.

Project **XCS-48(SA-8)** encompasses a 718-acre parcel of previously unmanaged brackish marsh and open water that is also part of the Sabine National Wildlife Refuge. Historic marsh losses in this parcel that forms a portion of the western rim of Calcasieu Lake were characterized as internal losses that occurred predominantly during the 1958-1974 time frame with continuing losses recorded in the 1974-1983 time frame. The marsh is today considered stable. Lake shore retreat due to wave action was also noted and along with overtopping by lake water are considered the most likely reasons should any losses occur in the future. Perimeter boundary effects of the Calcasieu Ship Channel on water levels and salinity regimes were identified as suspected reason for part of the marsh loss problem. Hurricanes were not identified as source of marsh loss or damage. Wind-induced erosion in shallow water and along shorelines are seen as the likely causes of marsh loss within this managed freshwater impoundment in the future. This active MM project would involve the installation of a rock weir in two of the several natural tributaries of the Black Bayou system that drain the project area. The frequency, duration and direction of communications this managed area would retain with Black Bayou and the unmanaged portion of the Black project

Southeast Sabine Lake

Project area **XCS-48(SO-1)** encompasses a 42,650-acre parcel of previously unmanaged intermediate and brackish marsh

types with relatively little open water. This parcel was historically mapped as intermediate and excessively drained saline marsh. The parcel was characterized as stable marsh with little loss. To apparently bring this area under management (i.e., passively operated HR) for the first time to mimic a historic condition would involve the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be largely reduced to whatever natural drainage would occur between the main stems of the natural bayous as well as what could/would occur through/over the plugs/weirs and when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SO-2)** is a 22,220-acre parcel. It contains some areas of previously unmanaged intermediate, brackish and saline marsh types. The wetland areas were historically mapped as excessively drained saline marsh. The marsh areas occur within an apparently continuous perimeter embankment. The marsh areas were characterized as stable with very little loss. To mimic the historic situation would involve installation of a water control structure (design unspecified). The frequency, duration and direction of communications the managed marshes in this parcel would retain with Sabine Lake would largely remain that which could/would occur when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SO-4)** encompasses a 6,800-acre currently managed parcel of the intermediate marsh type with relatively little open water. This parcel was historically mapped as brackish marsh. The parcel was characterized as stable marsh with very little loss but signs of and the potential for future losses were noted due to altered hydrology. To implement the proposed upgrade of an actively operated MM project would involve maintenance of the perimeter embankment, upgrading the in-place water control structure, and installation of a variable crest weir fitted with a flapgated culvert. The project area would continue to be an actively managed semi-impoundment. Thus, the frequency, direction and duration of communications this internal, managed area would retain with the unmanaged estuary could be increased to what was allowed to occur through additional water control structures, depending upon the operational plan (unspecified), and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment.

Q.9. Chenier/Basins Region Summary

See main text at 5.2.2.3.

Q.10. Coastwide Summary

See main text at 5.2.2.3.

Q.9. Chenier/Basins Region Summary

See main text at 5.2.2.3.

Q.10. Coastwide Summary

See main text at 5.2.2.3.

Table O-1 CWPPRA- Pontchartrain Basin (Basin 1)

PONTCHARTRAIN BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	CWPPRA PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA ACRES MM	CWPPRA ACRES HR	TYPE H2O MGT	Hydrologically Managed Acres Sustain	Hydrologically Managed Acres Reacquire	Hydrologically Managed Acres New	COMMENT	INCLUDED PERMITS
Cutoff Bayou PO-11	B	Candidate for priority listing	Reduce erosive tidal scour, salinity	Rehab existing structures	Slow internal marsh losses, invigorate existing marsh; more SAV		3915	Pass	3915	0	0		
Alligator Pt. PO-15	B	Permitted 1993, candidate for priority listing	Reduce erosive tidal scour, salinity	Install new water control structures at the perimeter	Slow internal marsh losses, invigorate existing marsh; more SAV		15578	Act	0	0	0	Area is included in boundaries of (MW-N O to Mobile)65 active marsh mgt plan	(MW-N O to Mobile)65 for marsh management
Manchac WMA XPO-51	I	Candidate for priority listing	Reduce soil salinity/seasonal salinity spikes	Install new water control structures at the perimeter	Slow general marsh losses, more SAV	8000		Act	0	0	8000	Public property; Initial effort to intensively manage surface hydrology	
St. Malo XPO-84	B	Candidate for priority listing	Reduce erosive tidal scour, salinity	Install new?water control structures at the perimeter	Slow internal marsh losses, invigorate existing marsh; more SAV		2089	Pass	0	0	1255	Very stable marsh	834 acs in (St. Bernard P wl)69
					Sub-totals	8000	21582		3915	0	9255		
					CWPPRA Footprint			29582					
					CWPPRA- Reacquire + Sustain			3915					
					CWPPRA- New Mgt Footprint			9255					
					CWPPRA- Reacquire + Sustain + New				13170				
					CWPPRA- Interface with permitted areas and nested CWPPRA projects				16412				
								TOTAL	29582				

Table Q-2. CWPPRA- Barataria Basin (Basin 4)

BARATARIA BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	CWPPRA PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA ACRES MM	CWPPRA ACRES HR	H2O MGT	Hydrologically Managed Acres Sustain	Hydrologically Managed Acres Reacquire	New	COMMENT	INCLUDED PERMITS
GIWW to Clovelly BA-2	F/A/B	1st Priority List; permitted	Better use fresh water/ sediments and nutrients; reduce tidal scour	Construct new perimeter structuresto reduce tidal scour; increase fresh water retention times; manage pump inputs	Slow marsh loss rate, invigorate existing marsh, more SAV		60000	Act	0	0	0	Effort to emulate inputs/surface flow patterns relative to historic sources, Includes areas seperately permitted as (Lafourche Par wl)733 & (Bayou Des Allemandes)107, NRCS is federal sponsor, acres counted under permits	(Lafourche P wl)733 (Lafourche P wl)743 (Bayou des Allemands)107
Hwy 90 to GIWW BA-6	F	Candidate for priority listing; permitted	Lower water levels, salinities; better use supplied fresh water, sediments & nutrients	Construct perimeter barriers to reduce tidal scour, increase fresh water retention times; manage pump inputs	Slow marsh loss rate, invigorate existing marsh, more SAV		40000	Act	0	0	0	Effort to emulate inputs/surface flow patterns relative to historic sources, Includes area seperately permitted as (Lafourche Par wl)540; NRCS is federal sponsor; acres counted under permits	(Lafourche P wl)540 (Lafourche P wl)743
Little Lake BA-14	B	Candidate for priority project listing	Rehab a portion of perimeter barriers between Little Lake and Lake Salvador	Rehab eroded levees/install water control structures to reacquire & upgrade former management capability	Slow marsh loss rates, invigorate existing marsh, more SAV	2998		Act	2548	0	0	Perpetuates/upgrades existing management capability, Includes area seperately permitted as (Jefferson Par wl)192	(Jefferson P wl)192
Leeville Marshes PBA-32	S	Candidate for priority listing	Protect fringing/internal marshes	Armor shoreline, install new perimeter water control structures	Slow general marsh losses	26500		Pass	0	0	26500	Shoreline erosion control efforts are wholly seperate, unrelated project components relative to hydrologic restoration; location, design and number of structures is undetermined	

				structures								relative to hydrologic restoration, location, design and number of structures is undetermined	

Table O-2 Continued

Bayou L'Ours Ridge PBA-34	I/B/S	Candidate for priority listing; design largely incomplete	Better use supplied fresh water, sediments & nutrients, reduce tidal scour	Construct new perimeter strucutres to reduce tidal scour, increase fresh water retention times; manage pump inputs	Slow marsh loss rates, invigorate existing marsh, more SAV		24765	Act	0	0	18099	Effort to emulate inputs/surface flow patterns relative to historic sources; maintaining boat access will be considered; (Lafourche P w/)529 was partially implemented and has expired	part of (Lafourche P w/) 529
Jonathan Davis Wetland PBA-35	I	2nd Priority List Permitted:	Reduce erosive tidal exchanges, salt water intrusion	Construct new perimeter barriers; rehab existing levees	Slow interior marsh loss rates; invigorate existing marsh, more SAV		7199	Pass	0	0	7199	Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; effort to emulate surface flow patterns relative to historic sources, boat access will be maintained, NRCS is federal sponsor	(Jefferson P w/)260
SE Lake Salvador PBA-61	I	Candidate for priority listing	Reduce shoreline erosion; reduce tidal scour along internal waterways	Install new shoreline erosion control features/perimeter barriers	Slow shoreline & internal marsh loss rates		3994	Pass	0	0	3994	Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; effort to emulate historic surface flows, boat access will likely decline	
Little Lake Canal Closure PBA-58	B	Candidate for priority listing	Reduce saltwater intrusion, tidal scour in internal marshes	Install plugs in 14 canals	Slow interior marsh loss rates; invigorate existing marsh		5847		0	0	5847		
Dupre Cut & Bayou Dupont XBA-70	B	Candidate for priority listing	Reduce saltwater intrusion, tidal scour in internal marshes	Install new shoreline erosion control features/4 water control structures and 2 plugs	Slow shoreline & internal marsh loss rates		3900		0	0	3900		
					Sub-totals	29498	145705		2548	0	65539		
					TOTAL CWPPRA Footprint		175203						
					CWPPRA- Reacquire + Sustain			2548					
					CWPPRA- New Mgt Footprint			65539					
					CWPPRA- Reacquire + Sustain + New				68087				
					CWPPRA- Interface with permitted areas				107116				
								total	175203				

Table O-3. CWPPRA- Terrebonne Basin (Basin 5)

TERREBONNE BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	CWPPRA PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA ACRES MM	CWPPRA ACRES HR	H2O MGT	Hydrologically Managed Acres Sustain	Hydrologically Managed Acres Reacquire	New	COMMENT	INCLUDED PERMITS
Penchant Sub-basin PTE-26	F/I/B	Conceptul, needs more study	Better use sediments, fresh water, nutrients	Construct internal/external barriers/shunts; redirect flows/sediments	Slow marsh loss rate, invigorate existing marsh				0	0	0	38,553 acres, too few details to apportion to MM or HR, appears efforts to emulate historic flows may also be spring board to manage some areas actively, appears to include formerly and currently mgd areas, assumes mgt of sub-units by individual landowners	
Subordinate/componet projects													
Brady Canal PTE-26b	F/I	3rd Priority List	Better use sediments, fresh water, nutrients	Construct new perimeter gated culverts/rock weirs; rehab existing levees; manage direct surface flows/ sediment & nutrient inputs	Maintain/invigorate existing marsh; more SAV		7653	Act	0	7653	0	Effort to emulate natural, historic hydrology but maximum benefit requires additional features/efforts; boat access reduced, creates a semi-isolated marsh; federal sponsor = NRCS	
Lake Chapeau PTE-23/ XTE-33	I/B	3rd Priority List	Reduce tidal scour, better use sediments/nutrients	Construct new perimeter rock weirs in natural and man-made waterways; rehab existing structures; construct new levee	Freshen existing marshes		13024	Act	0	13024	0	Effort to emulate natural, historic hydrology but maximum benefit requires additional features/efforts; boat access reduced, creates a semi-isolated marsh, federal sponsor = NRCS	
Parish Line of Defense XTE-28	F/I/B/S	Corresponds to a proposed hurricane protection alignment	Provide hurricane and marsh protection	Construct line of defense with dredged material/perimeter water control structures	Construct hurricane-grade barrier to flooding; reduce storm-induced marsh losses			Act				Permit applied for, concurrently under study by New Orleans Dist., COE as a potential Federal hurricane protection project	
Subordinate/componet projects													
Grand Bayou Wetland TE-5b	F/I	One of two parts already constructed, candidate priority listing	Reduce incidence of salinity-induced stresses	Construct new semi-impoundment; construct new manipulatable structures; construct new & rehab existing levees	Slow marsh loss rate, invigorate existing marsh, vegetate exposable substrates; more SAV	19130		Act	0	0	18180	Within footprint of XTE-28, could be stand-alone project, targets formerly unmanaged marsh, both public and private	
Pointe Au Chen TE-6	B	Engineering by LaDNR	Reduce influence of tidal factors, make better use of available fresh water	Construct new perimeter structures, manage water levels and manage fresh water inputs	Slow marsh loss rate; more SAV	5407		Act	0	0	5407	Within footprint of XTE-28, could be stand-alone project, regardless of status of XTE-28, targets formerly unmanaged marsh	

Table O-3 Continued

* Lake Boudreaux TE-7	F/\B	Parts incomplete	Reduce tidal exchange/salt water intrusion; increase water retention	Construct barriers internal to hurricane protection levee, limit exchange; manage surface flow patterns/rates	Slow marsh loss rate; Invigorate existing marsh, more SAV							Partly within footprint of XTE-28, manage marshes isolated by the hurricane protetion levee	
TE-7a	F/I	Permitted				4100		Act	0	0	0	Within footprint of XTE-28 & (Terrebonne P wl)943	(Terrebonne P wl)94: aaaa
TE-7b	I/B	Completed					3000		x	0	0	Within footprint of XTE-28	
TE-7c	I/B	Permitted					1600		1600	0	0	Within footprint of XTE-28	
TE-7d	I/B	Plan formulation by SCS				37300			36844	0	0	456 acs within (Terrebonne P wl)478	
* Bayou Pelton Wetland TE-8	I	Candidate for priority listing	Increase fresh water retention; reduce incidence of salt water intrusion	Construct new perimeter closures and water control structures in man-made and natural waterways, elevate natural levee	Slow marsh loss rate, Invigorate existing marsh, more SAV/vegetated substrate	2400		Act	0	0	2400	Within footprint of XTE-28, could be stand-alone project, regardless of status of XTE-28, targets formerly unmanaged marsh, creates semi-impoundment	
S Bayou Pelton XTE-56	I/B/S	Candidate for priority listing	Reduce tidal exchange	Plug embankment breaches	Forestall the advent of tidal/ salt water stresses		12200	Pass	0	0	12200	Abutts footprint of XTE-28, targets previously unmanaged marsh, stand-alone project	
S. Point Au Chen XTE-57	B	Candidate for priority listing	Reduce tidal exchange/salt water intrusion; increase water input/retention	Construct/rehab existing perimeter man-made features; construct new perimeter structures in man-made waterways; use dredged material to creat perimeter marsh	Slow marsh loss rate, Invigorate existing marsh, freshen existing marsh; more SAV		6090	Pass	0	0	6090	Abutts footprint of XTE-28, targets previously unmanaged marsh, stand-alone project, maximum benefit may be contingent upon XTE-28	
Subordinate Component Projects													
* Grand Bayou/Bully Camp XTE-47/ XTE-48	F/\B	Candidate for priority listing	Reduce tidal exchange/salt water intrusion, more fresh water input/retention	Construct new perimeter structures; manage/ surface waters	Slow marsh loss rate; Invigorate existing marsh; more SAV	5200		Act	0	0	5200	Abutts footprint of XTE-28, partially overlaps XTE-25, targets formerly unmanaged marsh	

Table O-3 Continued

* Bully Camp TE-9	B	Candidate for priority listing	Control surface water depths/quality	Construct new perimeter structures; manipulate water levels	Slow marsh loss rate, protect inland marshes	750		Act	0	0	400	350 acs within footprint of targets formerly unmanaged marsh	
* S Bully Camp XTE-58	B	Candidate for priority listing	Make better use of divertable fresh water; use dredged material to reclaim eroded substrates	Construct new perimeter weirs and plugs in natural & man-made waterways; install new culverts; maintain existing levees; use dredged material to reclaim eroded substrates	Slightly freshen marshes		12200	Pass	0	0	12200	Extends beyond footprint of XTE-28, stand-alone project; targets formerly unmanaged marsh, both public and private	
* Bayou Blue Water Mgt PTE-25	F/A/B	Candidate for priority listing	Change hydrology of fresh water	Construct new perimeter structures; redirect flows; prolong freshe water retention time	Slow marsh loss rate, invigorate marsh		18350	Act	0	0	13250	Abuts footprint of XTE-28, 4200 acs overlaps XTE-47/48, 900 acs within (Grand Bayou)169	
S Wonder Lake XTE-60	B/S	Candidate for priority listing	Protect remnant marsh	Construct line of defense, place structures in man-made and natural waterways	Slow marsh loss rate, more SAV		9400	Pass	0	0	5900	Abuts footprint of XTE-28, targets formerly unmanagd marsh, a stand-alone project, 3500 acs lie in XTE-29	
Subordinate/componet projects													
* Wonder Lake XTE-29	B	Plan formulation	Control surface water depths/quality	Construct/rehab existing barriers; conduct water level reductions	Slow marsh loss rate; invigorate remnant marsh	3500		Act	0	0	3500	Abuts footprint of XTE-28, targets formerly unmaged marsh, a stand-alone project that is also wholly contained within footprint of XTE-60; further compartmentalizes the marsh	
S Falgout Canal XTE-55	B	Candidate for priority listing	Reduce salt water intrusion; better use of avlalable water	Construct new/rehab existing structures; periodically input fresh water	Slow marsh loss rate; invigorate existing marsh, more SAV		22000	Pass	0	0	20523	Targets previously unmanged marsh; 1477 acs lie within permit areas	(Terrebonne P wf)49t (Terrebonne P wf)62 both no work/expired
S Fina LaTerre XTE-59	F/A/B	Candidate for priority listing	Off-set man-made isolation	Construct new structures, manage inflows	Slow marsh loss rate		19800	Pass	0	0	19800	Targets previously unmanged marsh, maximum benefits depend upon installation of the HurricaneProtection Project	Adjoins (Terrebonne P wf)6
Point Au Fer Canal Closures PTE-22/24	B/S	2nd Priority List, permitted in 1995 as Terrebonne Ph w/l 1044	Reduce salinity/tidal flux	Construct/reinforce barriers in man-made canals	Create defensive line; slow marsh loss rate		5400	Pass	0	0	x	Effort to emulate natural, historic hydrology, 230 acs within PTE-33; federal sponsor - NRCS, acreage listed in permit tables	
N-22					Sub-totals	77787	130717		38444	20677	125050		184171
					CWPPRA Footprint			208504					
					CWPPRA- Reacquire + Sustain			59121					
					CWPPRA- New Mgt Footprint			125050					
					CWPPRA- Reacquire + Sustain + New				184171				
					CWPPRA- Interface with permitted areas				24333				
								TOTAL	208504				

Table O-4 CWPPRAA- Teche-Vermilion Basin (Basin 7)

TECHE/VERMILION BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA ACRES MM	CWPPRA ACRES HR	H2O MGT	Hydrologically Managed Acres Sustain	Hydrologically Managed Acres Reacquire	New	COMMENT	INCLUDED PERMITS
Shark Island TV-1	B	1st Priority List	Reduce ponding/salt build-up in interior marshes, slow/halt shoreline erosion	Construct new perimeter structures, armor bankline	Slow internal marsh loss rate, shoreline erosion rate		2181	Act	0	0	2181	Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration, control exchange at man-made waterways only; federal sponsor - NRCS	
Cote Blanche TV-4	F	3rd Priority List; permitted 1995 as St. Mary Ph w/I 195a	Reduce erosive tidal action in interior marshes; better use available sediments; slow/halt shoreline erosion	Construct new perimeter structures, cut gaps, armor bankline	Slow internal marsh loss rate, shoreline erosion rate		30000	Act	0	0	x	Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration, construct rock weirs in man-made and natural waterways, acreage listed in permit tables	St. Mary Ph w/I 153
Marsh Island Canals TV-5/7a	B	Candidate for priority listing	Reduce tidal action, protect shoreline	Upgrade existing water control structure, armor bankline	Slow marsh loss/shoreline/ lake rim erosion rates, invigorate existing marsh		6697	Pass	6697	0	0	Shoreline erosion control/lake rim protection efforts are separate, unrelated project components relative to hydrologic restoration; plug only oil field canals	
Redfish Pt. TV-8	B	Candidate for priority listing	Reduce erosive tidal action in internal marsh; slow/halt shoreline erosion	Restore/upgrade existing water management capability; slow/ halt shoreline erosion	Reacquire/prolong management capability; slow/halt shoreline erosion rate		400	Act	0	400	0	Shoreline erosion control/lake rim protection efforts are separate, unrelated project components relative to management of the marsh	
Oaks/Avery Canals PTV10/XTV25	I	Candidate for priority listing	Slow/halt bank erosion, internal marsh loss	Construct new perimeter structures; armor bankline	Slow marsh loss rate		5365		5365	0	0	Targets two separate and unconnected pieces of marsh- one managed with a rock weir, the other with variable-crest structures, NRCS is Federal sponsor	
					Sub-totals	0	44643		12062	400	2181		
					CWPPRA Footprint			44643					
					CWPPRA- Reacquire + Sustain			12462					
					CWPPRA- New Mgt Footprint			2181					
					CWPPRA- Reacquire + Sustain + New				14643				
					CWPPRA- Interface with permitted areas				30000				
								TOTAL	44643				

Table Q-5: CWPPRA- Mermentau Basin (Basin 8)

MERMENTAU BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	CWPPRA PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA PROJECT ACRE MM	CWPPRA PROJECT ACRE HR	H2O MGT	Hydrologically Managed Acres Sustain	Hydrologically Managed Acres Reacquire	New	COMMENT	INCLUDED PERMITS
Sawmill Canal Structure PME-14	F/I/B	Candidate for priority listing	Maintain existing mgt capabilities to control water levels, salinity	Rehab/upgrade existing structures/barriers	Sustain/enhance biological productivity of currently managed area		2742	Act	2742	0	0	Perpetuates semi-impoundment management capability; see Cameron P wl 1014	
Humble Canal Structure PME-15	F/I	Candidate for priority listing	Reestablish prior mgt capability to control water levels	Replace existing failed structure	Reacquire ability to affect biological productivity of managed area for resident fish and wildlife		5500	Act	0	5500	0	Targets interior marshes, reestablishes semi-impoundment condition	
Coteau Plateau MM PME-16	F/I	Conceptual, may be candidate for priority listing in future	Reduce stressors; move to a site-specific rather than a large area water level &/or chemistrymanagement capability	Install new structures	Enhanced productivity; halt land loss	7300		Act	7300	0	0	Creates a site-specific water level/chemistry mgt capability; ends reliance upon a more distant structure; creates a semi-impoundment	
N. Little Pecan Bayou XME-40	F/I/B	May be candidate for priority listing	Maintain existing mgt capabilities to control water levels, salinity	Preventative maintenance & upgrade of existing water control structures	Sustain/enhance biological productivity of managed area; protect/invigorate existing marsh; more SAV		4467	Act	4467	0	0	Targets interior marshes; perpetuates semi-impoundment management capability	
Pumpkin Ridge Structure XME-45	I	May be candidate for priority listing	Reestablish prior protection; upgrade management capability; reduce salinity	Replace existing failed structure	Reacquire ability to affect biological productivity of managed area; reduce marsh loss; more SAV		1000	Act	0	1000	0	Targets interior marshes; perpetuates semi-impoundment mgt capability	
Rollover Bayou Structure XME-46	B/S	May be candidate for priority listing	Reestablish prior protection capability; reduce salinity	Replace existing failed structure	Reacquire ability to affect biological productivity of managed area		4000	Pass	0	4000	0	Targets interior marshes; includes boat bay	
Freshwater Bayou Shoreline Work ME-4	F/I	2nd Priority List	Stabilize shoreline; reduce losses of adjacent marsh	Install rip-rap/install new structures	Stop bank erosion; halt land loss; more SAV		14381	Pass	0	0	14381	Targets interior marshes; sponsored by NRCS	
Florence Canal XME-43	F	May be candidate for priority listing	Maintain existing mgt	Reconstruct eroded mgt levee	Reacquire ability to affect biological productivity of formerly managed area		1750		0	1750	0	Targets interior marshes; reestablishes semi-impoundment	
					Sub-totals	7300	33840		14509	12250	14381		
					CWPPRA Footprint			41140					
					CWPPRA- Reacquire + Sustain			26759					
					CWPPRA- New Mgt Footprint			14381					
					CWPPRA- Reacquire + Sustain + New				41140				
					CWPPRA- Interface with permitted areas and nested CWPPRA projects				0				
								TOTAL	41140				

Table 5-6: Continued

Creates semi-impoundment,

Table O-6 CWPPRA - Calcasieu-Sabine Basin (Basin 9)

CALCASIEU/SABINE BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN	Marsh Type	STATUS	CWPPRA PROJECT CONCEPT	CWPPRA PROJECT STRATEGY	CWPPRA EXPECTED RESULT	CWPPRA ACRES MM	CWPPRA ACRES HR	H2O MGT	Additional Hydrologically Managed Acres Sustain	Additional Hydrologically Managed Acres Reacquire	New	COMMENT	INCLUDED AREAS
East of Calcasieu Lake													
Highway 384 PCS-25	F/I	2nd Priority List	Reduce influence of Calcasieu Lake	Construct new & rehab existing structures; create barriers to free water exchange	Create conditions more favorable to marsh/aquatic plant growth; more SAV		650	Act	650	0	0	Variation of PCS-12/18 relative to historic sources, formerly managed area, sponsored by NRCS	
Tripod Bayou CS-14	B	Conceptual state-level project; candidate for priority listing	Improve hydrology in SW corner of Cameron-Creole watershed project; reduce local influence of Calcasieu Lake	Impose new controls to free water exchange	Establish/maintain water levels conditions more favorable to marsh plant growth	1186		Act	0	0	0	Already managed under permit; designed to relieve problem created/associated with the permitted action, sponsored by FWS	(Calcasieu Lake) 382
CS-10	B	Conceptual state-level project; candidate for priority listing	Reacquire/upgrade of former mgt capability; reduce water level fluctuation and incidence of saltwater intrusion	Create one semi-impoundment, vegetate exposable substrates; create another area mgd area influenced by a rock weir	Establish/maintain water level/chemistry conditions more favorable to marsh plant growth, more SAV	1462		Act	0	0	1462	Conceptual state project; two mgt cells - one mgd actively, one mgd passively	
West of Calcasieu Lake													
Southwest Calcasieu Lake													
Structures - Oyster & Mud Bayous PCS-12/18	B	Component of C/S Basin Plan; candidate for priority listing	Reduce tidal scour, water level fluctuations and incidence of saltwater intrusion	Impose new controls to free water exchange	Establish/maintain water level/chemistry conditions more favorable to marsh plant growth		7650	Pass	0	0	0	Unspecified structure design, supports C/S perimeter protection plan, designed to affect interior marsh areas, includes portion of (Oyster Bayou)7, effort to emulate inputs/surface flow patterns relative to historic sources, boat access a consideration, wholly contained within footprint of SO-8	

Table Q-6 Continued

* Oyster Bayou/Lake Unit XCS-48 (SO-6)	B	Component of C/S Basin Plan, awaits feasibility study, may be candidate for priority listing				12600	Pass	0	0	12600	Targets previously unmanaged marsh, totally contains footprint of PCS 12/18, with PCS 12/18 structures	
W. Mud Lake XCS-48 (SO-5)	I/B	Component of C/S Basin Plan; candidate for priority listing	Reduce water levels, promote better internal circulation; upgrade of existing mgt capability	Add a variable crest weir to an existing structure & adjust invert of other existing culverts to better control water exchange	Reestablish/maintain water level conditions more favorable to marsh plant growth	9800	Act	6200	0	0	Designed to affect formerly managed interior marsh; can influence hydrology/water chemistry/operational criteria in PCS-24, East Mudd Lake MM area controlled by active MM structure (XCS-48N)	3600 acs permitted as (Cameron Ph wf) 967
East Mud Lake PCS-24	B	1st Priority List	Reduce/control water levels/ chemistry	Upgrade existing/construct new water control structures	Slow marsh loss/shoreline erosion rates, more SAV, invigorate existing marsh, vegetate eroded/exposable	6100	Act	0	0	0	Revised version of (Cameron P wf) 923 (dated 3/26/92) permitted nearly identical project, same as SO-6, acres counted under permits sponsored by NRCS	(Cameron Parish wf) 923
"West-central Calcasieu Lake"												
West Cove Canal Plug XCS-44	S	Candidate for priority listing	Affect movement pattern of tidal water	Construct a new plug	Reestablishes West Cove Canal integrity	4390	Pass	0	0	4390	Supports C/S basin permimeter protection plan, restores hydrology of canal system, includes a portion of XCS48(SA-10) & all of NRCS project SA-9	
Replace Refuge Structures XCS-47/ 48 j,k&p	I/B	3rd Priority List	Prolongation/added flexibility of current mgt capability	Replace/upgrade existing structures	Re-establish/maintain water level conditions more favorable to marsh plant growth	42247	Act	3720	0	0	Supports C/S basin permmeter protection plan but designed to affect interior marshes, including a big part of Sabine NWR; potential to increase fisheries access, greater water level/chemistry control, other 38,527 acs included with NO-8A, SA-1, SA-2 & SO-4, sponsored by FWS	part of (Cameron P wf)963 all of (Cameron P wf)863
No. Line Canal Structure XCS-46	I/B	Candidate for 5th priority list	Recreate hydrologic boundary between Sabine & Calcasieu basins; enhance flexibility effectiveness of eastern refuge structures	Construct barrier to E-W water movement	Emulates historic internal boundary between Sabine and Calcasieu basins	12012	Pass	0	0	0	A stand-alone project, but also closes hydrologic back door for Refuge and Rycade Canal structures, thus component of perimeter control control strategy, structure design uncertain, all acs accounted for under SA-1, NO-8 & NO-8a	
Browns Lake/Starks Canal XCS-48 (SA-1)	I/B	Candidate for priority listing	Prolongation/added flexibility of current mgt capability	Maintain integrity of existing perimeter levee, replace or build several control structures	Prolongs/improves mgt capability for waterfowl and freshwater fisheries	28500	Act	28500	0	0	Upgrade of continuously managed refuge area; a stand-alone project unrelated to any other project in basin, controlled by active mm structure (XCS-48I)	
S Back Ridge XCS-48 (SA-2)	I/B	Candidate for priority listing	Prolongation of existing management capability	Maintain integrity of existing perimeter levee system	Reduces the potential for marsh loss due to levee failure	7552	Act	7552	0	0	Prolongation of existing management capability of Refuge impoundment	

Table O-6 Continued

Northwest Calcasieu Lake

Browns Lake CS-9	B	2nd Priority List	Create management capability; control water depth/chemistry	Construct semi-impoundment	Create/maintain conditions more favorable to marsh/aquatic plant growth; more SAV; possibly vegetate eroded/exposable substrate	2800		Act	0	0	2800	Until constructed, area will be influenced by the Alkali Ditch structure. Once built, area will function independently from any other area in the basin; includes portions opl ¨-14 & NO-1; sponsored by NRCS	
Alkali Ditch Structure XCS-53	B	Candidate for priority listing; essential component of CWPPRA perimeter protection	Reduce influence of major connection with Calcasieu Lake via GIWW	Construct new partial barrier to free water exchange	Create conditions more favorable to marsh/aquatic plant growth		2500	Pass	0	0	0	Supports C/S basin permimeter protection plan; designed to affect interior marshes, effects encompass NO-1, NO-2a and NO-5; structure includes a boat bay; included in NO-5	
N. Blk. Lake CS-8/ XCS-48 (NO-2a)	B	Candidate for priority listing	Reacquire mgt.capability	Reconstruct barriers to free water exchange	Create conditions more favorable to marsh/aquatic plant growth; more SAV/ vegetated eroded/exposable substrate	800		Act	0	0	0	Formerly leveed private wetland; (Black Lake 30, dated 1982 - F/I marsh) permitted nearly identical project; Until constructed, area will be influenced by the Alkali Ditch structure. Once built, area will function independently from any other area in the basin	(Black Lake)30
S. Brown Lake XCS-48 (NO-5)	B	Candidate for priority listing	Create management capability; control water depth/chemistry	Repair embankments; install new water control structures	Create conditions more favorable to marsh/aquatic plant growth; more SAV/ vegetated eroded/exposable substrate		11700	Pass	0	0	11000	Area not included in CS-9	
NE. Blk. Lake XCS-48 (NO-2)	I/B	Candidate for priority listing	Prolongation/added flexibility of current mgt capability	Maintain integrity of existing perimeter levee, upgrade existing, build new structures	Prolongs/improves mgt capability for waterfowl and freshwater fisheries; vegetate eroded, exposable substrates; more SAV	1300		Act	0	0	0	Upgrade of continuously managed private area; contained within XCS-53 and PCS-14	(Cameron P wf)832
W. Blk. Lake XCS-48 (NO-4)	I/B	Candidate for priority listing	Prolongation/added flexibility of current mgt capability	Maintain integrity of existing perimeter levee, upgrade structures	Prolongs/improves mgt capability; more SAV; vegetate eroded, exposable substrates	6600		Act	0	0	0	Upgrade of continuously managed private area; (Cameron P wf) 744 (dated 1966, F/I) permitted nearly identical project	(Cameron P wf)744
Rycade Canal Structure CS-2	I/B	Installed, essential component of CWPPRA perimeter protection	Reduce influence of major connection with Calcasieu Lake	Construct adjustable barrier to free water exchange	Create conditions in interior areas favorable to marsh/aquatic plant growth		10000	Act	0	0	0	Essential component of basin permimeter protection plan until Alkali Ditch structure is built; thereafter, reduced to strategically located internal structure providing basis for more intensive mgt efforts of internal marshes; all areas contained within SA-1, NO-8 two permitted areas	
SW Black Lake XCS-48 (NO-8)	B	Candidate for priority listing	Prolongation/added flexibility of current mgt capability	Maintain integrity of existing perimeter levee, install structures	Prolongs/improves mgt capability; invigorate existing marsh	4600		Act	0	0	0	Until implemented, affected by Rycade Canal structure; upgrade of continuously managed private area, to be managed for fresher marsh type	Within footprint of (Cameron P wf)963
Kelso Bayou Structure PCS-14	B	Candidate for priority listing; componet of CWPPRA perimeter protection plan	Reduce influence of major connection with Calcasieu Lake	Construct new partial barrier to free water exchange in a natural waterway	Targets previously unmanaged interior marsh; create conditions more favorable to marsh/aquatic plant growth		2500	Pass	0	0	0	Supports C/S basin permimeter protection plan; potential seperate project, but reduced exchange increases effect of Alkali Ditch/Rycade Canal structures; acreage accounted for in CS-9, XCS-53, XCS-48, NO-5 and NO-2	
Black Bayou Cutoff Canal & Mgt Area XCS-48 NO-3	I	Upgrade existing mgt capability	Maintain existing perimeter levee system; affect fresh water introductions, install new water control strucutres	Stimulate wetland productivity	Targets area managed as agri-cultural pump-off for a cattle, now managed for waterfowl and fresh water fisheries	4100		Pass	4100	0	0	Management of existing managed area	

Table O-6 Continued

Northeast Sabine Lake

Barrus Bayou XCS 46 (NO-14a)	I/B	Candidate for priority listing; part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct several rock weirs; increase sediment retention, reduce salinity levels	Conversion of some saltier marsh to fresher forms		3600	Pass	0	0	3600	Targets formerly unmanaged interior marsh, a stand alone project; creates a semi isolated marsh area; could receive water discharges from NO-14
GIWW/Black Bayou Marsh CS 5a/12	I A/B	Candidate for priority listing, part of State plan; feasibility study complete	Reduce estuarine influences, tighten hydrologic boundaries; better use supplied fresh water; many structures components of perimeter protection strategy	Construct a series of perimeter and internal structures (adjustable and fixed) to control exchanges between and the retention time of introduced freshwater within management units	Create conditions in interior areas more favorable to marsh/aquatic plant growth		30850	Act	0	0	0	Supports C/S basin perimeter protection plan, attempts to emulate historic fresher water inputs; relies upon a collection of several often interdependent projects to emulate historic fresher water conditions in perimeter and interior marshes, maintaining boat access will be considered, covers footprint of XCS-46 (NO-13 thru NO-20), targets formerly unmanaged marsh
W. Gum Cove/ Black Bayou XCS 46 (NO-14)	I	Candidate for priority listing, design incomplete	Reduce water level fluctuation; erosive tidal scour and incidence of saltwater intrusion	Construct rock weirs at natural exchange points to control surface flows	Prolong existing marsh type in interior area	4200		Pass	0	0	4200	Targets formerly unmanaged interior marsh, a potential stand alone project; creates a semi isolated marsh area; within footprint of and includes component structures of CS-5a/12, infusion of fresh water may intensify response; discharges water to NO-14a
Blk. Bayou Cutoff XCS 46 (NO-15)	I	Candidate for priority listing, part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct new in/rehab existing structures/levees that define the hydrologic boundaries on 3 sides of the targeted area	Prolong existing marsh type		800	Pass	0	0	800	Targets formerly unmanaged perimeter marsh, a potential stand alone project; within footprint of and includes component structures of CS-5a/12, infusion of fresh water may intensify response
NW Black Bayou XCS 46 (NO-17)	I	Candidate for priority listing; part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct 2 rock weirs in exchange points along a man made waterway; rehab existing levees	Prolong existing marsh type; increase sediment retention		2850	Pass	0	0	2850	Targets formerly unmanaged perimeter marsh, a potential stand alone project; within footprint of and includes component structures of CS-5a/12; includes XCS 46d (NO-17, creates a semi isolated marsh area, infusion of fresh water may intensify response, culvert delivers water to NO-18
SE Black Bayou XCS 46 (NO-18)	I/B	Candidate for priority listing; part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct 22 rock weirs in natural exchange points	Conversion of some saltier marsh to fresher forms		4800	Pass	0	0	4800	Targets formerly unmanaged interior marsh, a potential stand alone project; within footprint of and includes component structures of CS-5a/12; creates a semi isolated marsh area, infusion of fresh water may intensify response, culvert delivers water to NO-19
Black Bayou XCS 46 (NO-19)	I/B	Candidate for priority listing; part of C/S River Basin Study	Reduce incidence of high salinity events, winter droughts & wave erosion in open water areas	Construct 1 rock weir/1 plug in man made and natural waterways; install wave breaks and sediment retention features in internal open water areas open water area	Conversion of some saltier marsh to fresher forms; more SAV; reduce wave induced erosion of open water shorelines		10820	Pass	0	0	10820	Targets formerly unmanaged perimeter marsh, a potential stand alone project; within footprint of and includes component structures of C/S 5a/12; infusion of fresh water may intensify response
W. Blk. Bayou XCS 46 (NO-20)	I/B	Candidate for priority listing, part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct 5 rock weirs in natural exchange points	Conversion of some saltier marsh to fresher forms; more vegetated surface; invigorate existing vegetation		1680	Pass	0	0	1680	Targets formerly unmanaged interior marsh, a potential stand alone project; within footprint of and includes component structures of CS-5a/12, creates a semi-isolated marsh area, infusion of fresh water may intensify response
SW Blk. Bayou XCS 46 (NO-21)	B	Candidate for priority listing; part of C/S River Basin Study	Reduce water level fluctuation and incidence of saltwater intrusion	Construct 12 rock weirs in natural exchange points; a plug in a man-made waterway; install wave breaks/sediment retention features in internal open water area	Conversion of some saltier marsh to fresher forms; more vegetated surface; invigorate existing vegetation		8650	Pass	0	0	8650	Supports C/S basin perimeter protection plan, targets formerly unmanaged perimeter marsh, potential separate project, part of Sabine NWR
NW Gum Cove XCS 46 (NO-13)	I A	River Basin Study listing, part of C/S River Basin Study	Reacquire/upgrade of former mgt capability	Reconstruct barriers to control water exchange	Create conditions more favorable to marsh/aquatic plant growth; convert to fresh marsh		4400	Act	4400	0	0	Upgrade of formerly managed area

Table O-6 Continued

East-central Sabine Lake

GIWW-Sabine River Rock Weirs PCS-10	B	Candidate for priority listing, part of C/S River Basin Study, component ofCWPPRA perimeter protection plan	Reduce water level fluctuation and incidence of saltwater intrusion	Construct rock weirs in man-made exchange points	Create conditions more favorable to marsh/aquatic plant growth	1680	Pass	0	0	0	Critical component of C/S basin plan, targets formerly unmanaged perimeter marsh, potential separate project; creates semi-isolated marsh area; totally contained within XCS-48 (NO-21)
Sabine Lake Closures PCS-11	B	Candidate for priority listing, part of C/S River Basin Study; integral component of CWPPRA perimeter protection plan	Reduce water level fluctuation and incidence of saltwater intrusion	Construct several new perimeter structures in man-made water ways	Invigorate existing marsh, reduce marsh loss rate	600	Pass	0	0	0	Totally within XCS-48(SA 5 & 7) structures (unspecified design and area of effect), a boat bay will be considered, targets Sabine NWR holdings
Greens Lake XCS-48 (SA-5)	B	Candidate for priority listing; part of C/S River Basin Study, planning incomplete	Simulate former surface water flow patterns; reduce incidence of salt water intrusion/water levels/ erosive effects of wind-generated waves	Install structures in natural and man-made waterways; redirect internal surface flow patterns; increase sediment retention; reduce wave action on interior marsh shorelines	Invigorate existing marsh, reduce marsh loss rate	26378	Act	26378	0	0	Targets formerly managed marsh in Sabine NWR, supports C/S perimeter protection plan, potential stand-alone project; includes a portion of PCS-11
S Willow Bayou XCS-48 (SA-7)	B	Candidate for priority listing; part of C/S River Basin Study, planning incomplete	Generally reduce water levels/ erosive effects of wind-generated waves in internal open water area	Reacquire/upgrade water mgt capability; increase sediment retention, reduce wave action on interior marsh shorelines; redirect internal surface flow patters	Invigorate existing marsh; reduce marsh loss rate; more SAV	6266	Act	0	0	6266	Targets formerly unmanaged perimeter marsh, emulates historic surface flow patterns, maximum benefit from structure used to control water level; potential stand-alone project; part of Sabine NWR ; includes most of PCS-11
Deep Lake Bayou Unit XCS-48 (SA-6)	I/B	Candidate for priority listing, part of C/S River Basin Study, planning incomplete	Reduce incidence of salt water intrusion; reduce erosive effect of wind-generated waves	Structures installed in surrounding units will provide protection against salt water; reduce wave action on interior marsh shorelines	Invigorate existing marsh, stimulate marsh expansion; more SAV	7418	Pass	0	0	7418	Targets formerly unmanaged interior marsh, success/benefits depend upon installation of adjacent projects; part of Sabine NWR, listed as sediment trapping
West Cove Canal Unit XCS-48 (SA-10)	B/S	Candidate for priority listing; part of C/S River Basin Study, planning incomplete	Reduce incidence of salt water intrusion; reduce erosive effect of wind-generated waves	Install new and upgrade mgt capability of existing structure on canal	Offset marsh loss, increase diversity	4600	Act	0	0	2000	Targets formerly unmanaged perimeter marsh, includes water control upgrades/and acres that are part of XCS-44
Northwest Cove XCS-48 (SA-8)	B	Candidate for priority listing, part of C/S River Basin Study, planning incomplete	Reduce incidence of salt water intrusion; reduce erosive effect of wind-generated waves	Maintain existing embankments; install new water control structures	Offset marsh loss, increase diversity	718	Act	0	0	718	Targets formerly unmanaged perimeter marsh

Table O-6 Continued

Southeast Sabine Lake

Johnson's Bayou XCS-48 (SO-1)	I/B	Candidate for priority listing; part of C/S River Basin Study; planning incomplete	Reduce water level fluctuation and incidence of saltwater intrusion; increase freshwater retention	Construct 16 rock weirs, 14 plugs in natural and man-made waterways	Reduction of brackish marsh acreage; expansion of intermediate marsh acreage; invigorate marsh; more SAV		42650	Pass	0	0	41450	Targets formerly unmanaged perimeter marsh; a potential stand-alone project; some attempt to emulate historic surface water patterns; seems to create a semi-isolated marsh area
SW Johnson's Bayou XCS-48 (SO-2)	I/B/S	Candidate for priority listing; part of C/S River Basin Study; planning incomplete	Create conditions conducive to perpetuating current marsh types; reduce incidence of salt water intrusion, water level fluctuations	Construct rock weir in natural exchange point at lake rim, and two more structures (unspecified type) upstream from the rock weir specifically to protect an area of intermediate marsh; construct shoreline protection	Prolongation of existing types/acreages; invigorate existing marsh; more SAV		22220	Pass	0	0	22220	Targets formerly unmanaged marsh; a potential stand-alone project; acreage affected may be overstated; listed as shore protection
Four Mile Square XCS-48 (SO-4)	I	Candidate for priority listing; part of C/S River Basin Study; planning incomplete	Restore former management capability	Increase water level mgt capability	Maintain/invigorate current marsh types, vegetate exposable marsh substrates		6800	Act	6800	0	0	Targets currently managed marsh; stand alone project
Southwest West Cove XCS-48 (SO-7)	B	Candidate for priority listing; part of C/S River Basin Study; planning incomplete	Create conditions conducive to perpetuating current marsh types; reduce incidence of salt water intrusion, water level fluctuations	Maintain existing embankments; install rock structures	Prolongation of existing types/acreages; invigorate existing marsh; more SAV		2400		0	0	2400	Targets formerly unmanaged area
					Sub-totals	115695	259354		88500	0	150344	
					CWPPRA Footprint			375049				
					CWPPRA- Reacquire + Sustain			88500				
					CWPPRA- New Mgt Footprint			150344				
					CWPPRA- Reacquire + Sustain + New				238844			
					CWPPRA- Interface with permitted areas and nested CWPPRA projects				136205			
								TOTAL	375049			

Table Q-7: CWPPRA

BASIN 1: Pontchartrain

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	0				0
F/I	0				0
I	8000			8000	0
F/I/B	0				0
I/B	0				0
B	5170	3915		1255	3915
I/B/S	0				0
B/S	0				0
S	0				0
Sub-totals		3915	0	9255	3915
Basin Total	13170				

n=3

Table Q-8 CWPPRA

BASIN 4: Barataria

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	0				0
F/I	0				0
I	3994			3994	0
F/I/B	0				0
I/B	0				0
B	12295	2548		5847 3900	2548
I/B/S	18099			18099	0
B/S	0				0
S	26500			26500	0
Sub-totals		2548	0	58340	2548
Basin Total	60888				

n=6

Table Q-9: CWPPRA

BASIN 5: Terrebonne

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	0				0
F/I	25833		7653	18180	7653
I	2400			2400	0
F/I/B	38250			5200 13250 19800	0
I/B	51468	1600 36844	13024		51468
B	48120			5407 6090 400 12200 20523 3500	0
I/B/S	12200			12200	0
B/S	10900			5900 5000	0
S	0				0
Sub-totals		38444	20677	130050	59121
Basin Total	189171				

n=18

Table Q-10: CWPPRA

BASIN 7: Teche-Vermilion

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	0				0
F/I	0				0
I	5365	5365			5365
F/I/B	0				0
I/B	0				0
B	9278	6697	400	2181	7097
I/B/S	0				0
B/S	0				0
S	0				0
Sub-totals		12062	400	2181	12462
Basin Total	14643				

n=4

Table Q-11: CWPPRA

BASIN 8: Mermentau

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	1750		1750		1750
F/I	27181	7300	5500	14381	12800
I	1000		1000		1000
F/I/B	7209	2742 4467			7209
I/B	0				0
B	0				0
I/B/S	0				0
B/S	4000		4000		4000
S	0				0
Sub-totals		14509	12250	14381	26759
Basin Total	41140				

n=8

Table Q-12: CWPPRA

BASIN 9: Calcasieu/Sabine

Included Marsh Type	Marsh Type Totals	Sustain	Reacquire	New	Sub-total Sustain + Reacquire
F	0				0
F/I	5250	650 4600			5250
I	18950	6800 4100		4200 900 2950	10900
F/I/B					0
I/B	109450	3720 28500 7552		3500 4800 10920 1680 7418 41360	39772
B	70294	26378		1462 12600 6650 6286 718 2400 2800 11000	26378
I/B/S	22200			22200	0
B/S	2000			2000	0
S	4390			4390	0
Sub-totals		82300	0	150234	82300
Basin Total	232534				

n=28

Table Q-13: CWPPRA

CWPPRA: Basin by Included Marsh Type (Total Acres)

Included Marsh Type	Basin 1	Basin 4	Basin 5	Basin 7	Delta Basins	Basin 8	Basin 9	Chenier Basins	Coastwide
F (Total)	0	0	0	0	0	1750	0	1750	1750
Sustain	0	0	0	0	0	0	0	0	0
Reacquire	0	0	0	0	0	1750	0	1750	1750
New	0	0	0	0	0	0	0	0	0
S + R	0	0	0	0	0	1750	0	1750	1750
F/I (Total)	0	0	25833	0	25833	27181	5250	32431	58264
Sustain	0	0	0	0	0	7300	5250	12550	12550
Reacquire	0	0	0	0	0	5500	0	5500	5500
New	0	0	25833	0	25833	14381	0	14381	40214
S + R	0	0	0	0	0	12800	5250	18050	18050
I (Total)	8000	3994	2400	5365	19759	1000	18950	19950	39709
Sustain	0	0	0	5365	5365	0	10900	10900	16265
Reacquire	0	0	0	0	0	1000	0	1000	1000
New	8000	3994	2400	0	14394	0	8050	8050	22444
S + R	0	0	0	5365	5365	1000	10900	11900	17265
F/I/B (Total)	0	0	38250	0	38250	7209	0	7209	45459
Sustain	0	0	0	0	0	7209	0	7209	7209
Reacquire	0	0	0	0	0	0	0	0	0
New	0	0	38250	0	38250	0	0	0	38250
S + R	0	0	0	0	0	7209	0	7209	7209
I/B (Total)	0	0	51468	0	51468	0	109450	109450	160918
Sustain	0	0	38444	0	38444	0	39772	39772	78216
Reacquire	0	0	13024	0	13024	0	0	0	13024
New	0	0	0	0	0	0	69678	69678	69678
S + R	0	0	0	0	0	0	39772	39772	39772
B (Total)	5170	12295	48120	9278	74863	0	70294	70294	145157
Sustain	3915	2548	0	6697	13160	0	26378	26378	39538
Reacquire	0	0	0	400	400	0	0	0	400
New	1255	9747	48120	2181	61303	0	43916	43916	105219
S + R	3915	2548	0	7097	13560	0	26378	26378	39938
I/B/S (Total)	0	18099	12200	0	30299	0	22200	22200	52499
Sustain	0	0	0	0	0	0	0	0	0
Reacquire	0	0	0	0	0	0	0	0	0
New	0	18099	12200	0	30299	0	22200	22200	52499
S + R	0	0	0	0	0	0	0	0	0
B/S (Total)	0	0	10900	0	10900	4000	2000	6000	16900
Sustain	0	0	0	0	0	0	0	0	0
Reacquire	0	0	0	0	0	4000	0	4000	4000
New	0	0	10900	0	10900	0	2000	2000	12900
S + R	0	0	0	0	0	0	0	0	0
S (Total)	0	26500	0	0	26500	0	4390	4390	30890
Sustain	0	0	0	0	0	0	0	0	0
Reacquire	0	0	0	0	0	0	0	0	0
New	0	26500	0	0	26500	0	4390	4390	30890
S + R	0	0	0	0	0	0	0	0	0
Basin									
Totals	13170	60888	189171	14643		41140	232534		
Avgs	4390	10148	10510	3661		5143	8305		
n=	3	6	18	4		8	28		
Delta									
Totals					277872				
Avgs					8684				
n=					31				
Chenier									
Totals								273674	
Avg								7602	
n=								36	
Coast									
Total									551546
Avg									8232
n=									67

Table Q-14: CWPPRA- Summary of Basins/Regions by Included Marsh Type

	Basin 1	Basin 4	Basin 5	Basin 7	Basin 8	Basin 9	Delta Totals	Chenier Totals	Coastwide Totals
F					1750			1750	1750
F/I			25833		27181	5250	25833	32431	58264
I	8000	3994	2400	5365	1000	18950	19759	19950	39709
F/I/B			38250		7209		38250	7209	45459
I/B			51468			109450	51468	109450	160918
B	5170	12295	48120	9278		70294	74863	70294	145157
I/B/S		18099	12200			22200	30299	22200	52499
B/S			10900		4000	2000	10900	6000	16900
S		26500				4390	26500	4390	30890
Totals	13170	60888	189171	14643	41140	232534	277872	273674	551546
Avg	4390	10148	10510	3661	5143	8305	8964	7602	8232
n=	3	6	18	4	8	28	31	36	67

Table Q-15: CWPPRA- Included Marsh Type

	Cumulative Delta	Cumulative Chenier	Cumulative Coastwide
F		1750	1750
F/I	25833	34181	60014
I	45592	54131	99723
F/I/B	83842	61340	145182
I/B	135310	170790	306100
B	210173	241084	451257
I/B/S	240472	263284	503756
B/S	251372	269284	520656
S	277872	273674	551546

Table Q-16: CWPPRA- Management Strategy by Included Marsh Type(s)

	Delta				Chenier				Coastwide			
	Sustain	Reacquire	New	Cumulative	Sustain	Reacquire	New	Cumulative	Sustain	Reacquire	New	Cumulative
F						1750		1750		1750		1750
F/I			25833	25833	12550	5500	14381	34181	12550	5500	40214	60014
I	5365		14394	45592	10900	1000	8050	54131	16265	1000	22444	99723
F/I/B			38250	83842	7209			61340	7209		38250	145182
I/B	38444	13024		135310	39772		69678	170790	78216	13024	69678	306100
B	13160	400	61303	210173	.26378		43916	241084	39538	400	105219	451257
I/B/S			30299	240472			22200	263284			52499	503756
B/S			10900	251372		4000	2000	269284		4000	12900	520656
S			26500	277872			4390	273674			30890	551546
Totals	56969	13424	207479		96809	12250	164615		153778	25674	372094	
	277872				273674				551546			

Table Q-17: CWPPRA- Summary Included Marsh Type by Mgt Strategy

Management Strategy	Cumulative Delta	Cumulativ Chenier	Total Coastwid	Cumulative Coastwide
Sustain	56969	96809	153778	153778
Reacquire	13424	12250	25674	179452
New	207479	164615	372094	551546
Total	277872	273674	551546	

Figure Q-1 - CWPPRA: Future

Delta Basins x Marsh Type

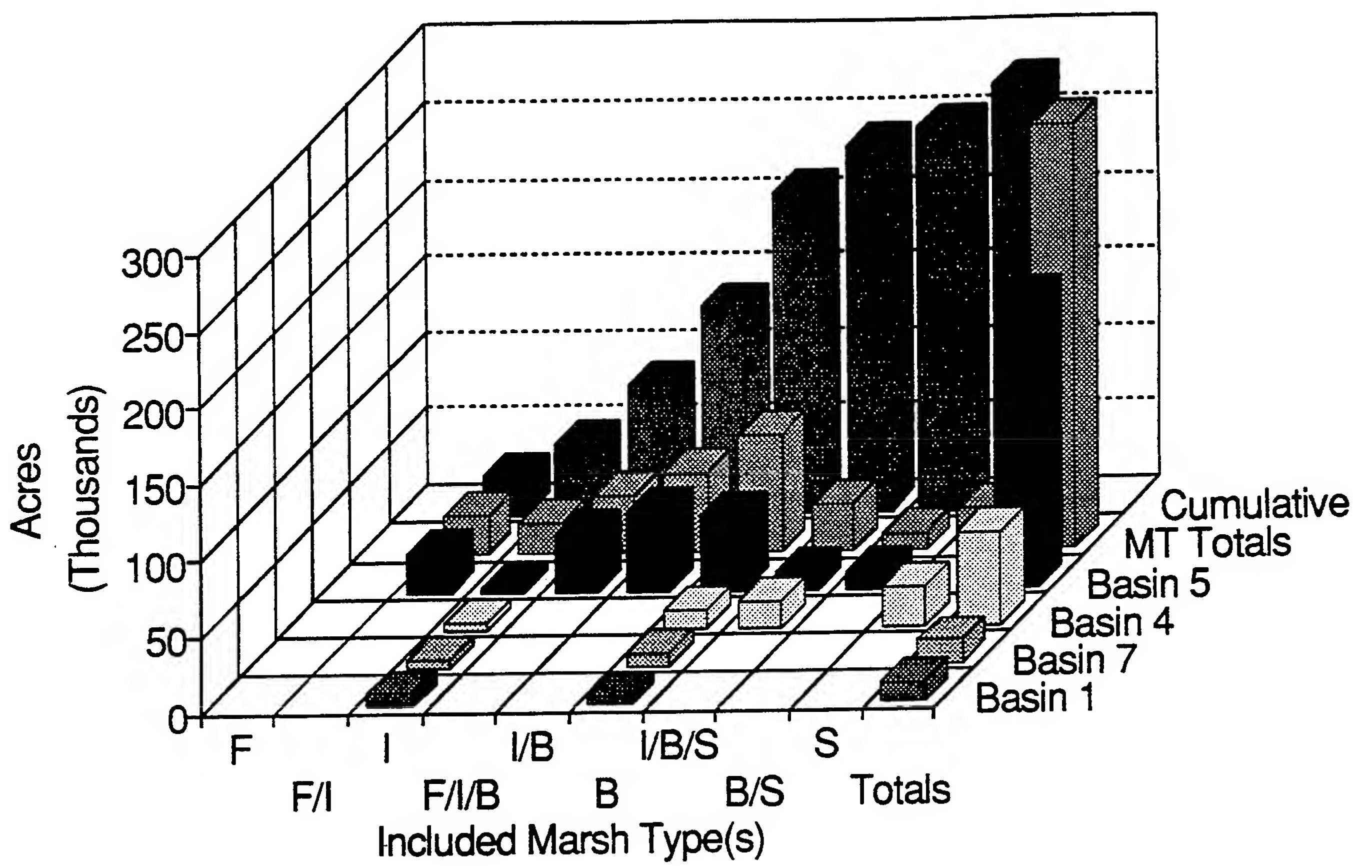


Figure Q-2 - CWPPRA: Future

Chenier Basins x Marsh Type

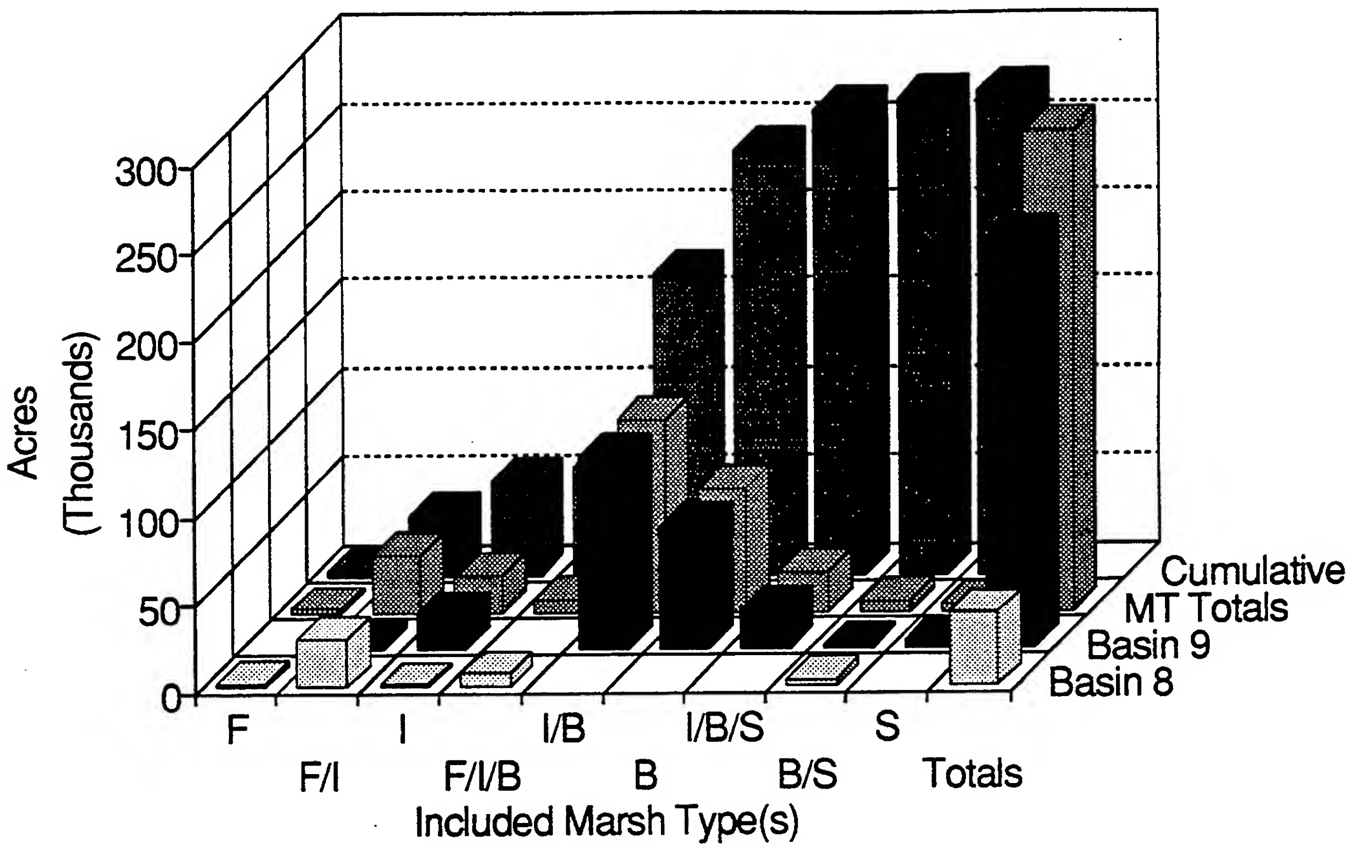


Figure Q-3 - CWPPRA:Future

Included Marsh Type (Coastwide)

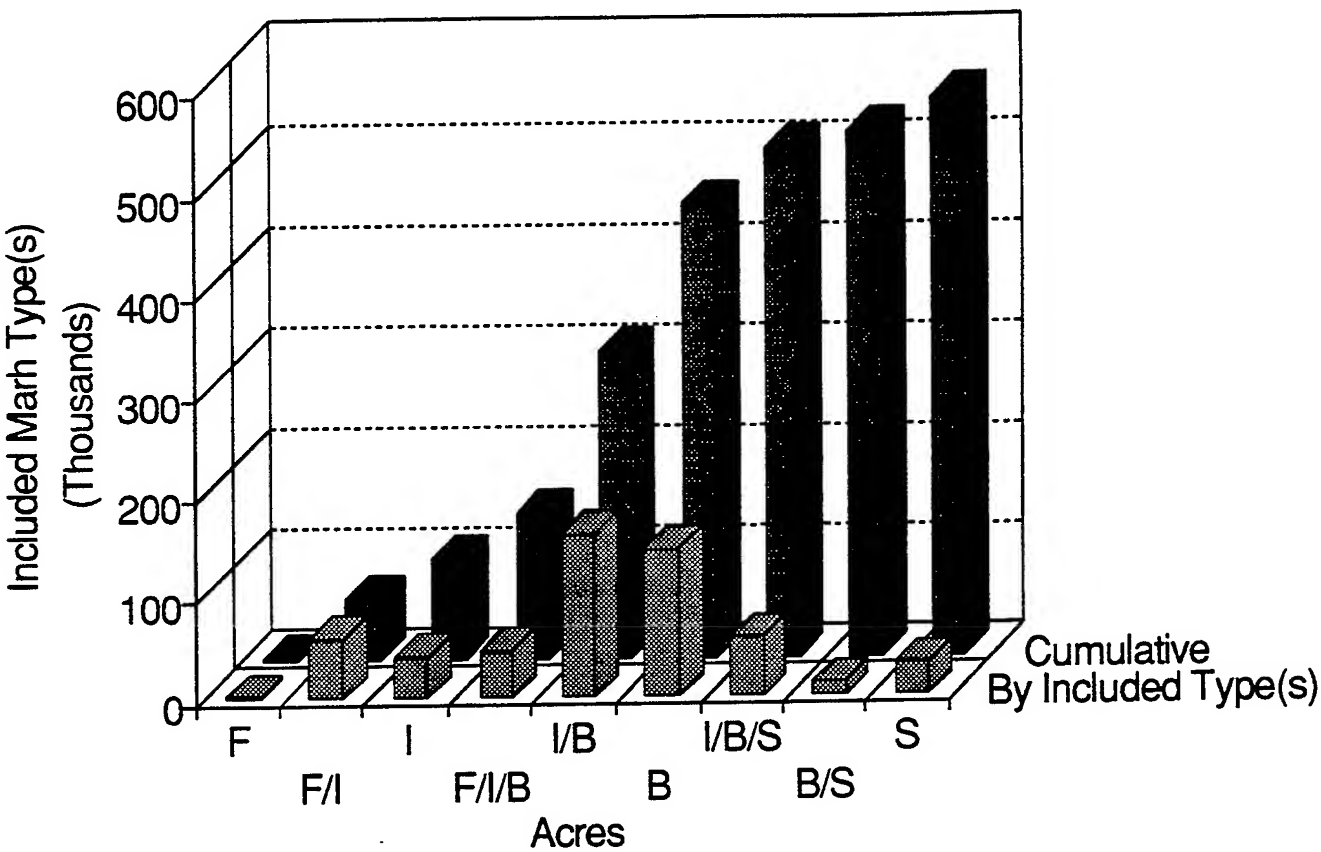


Figure Q-4 - CWPPRA: Future

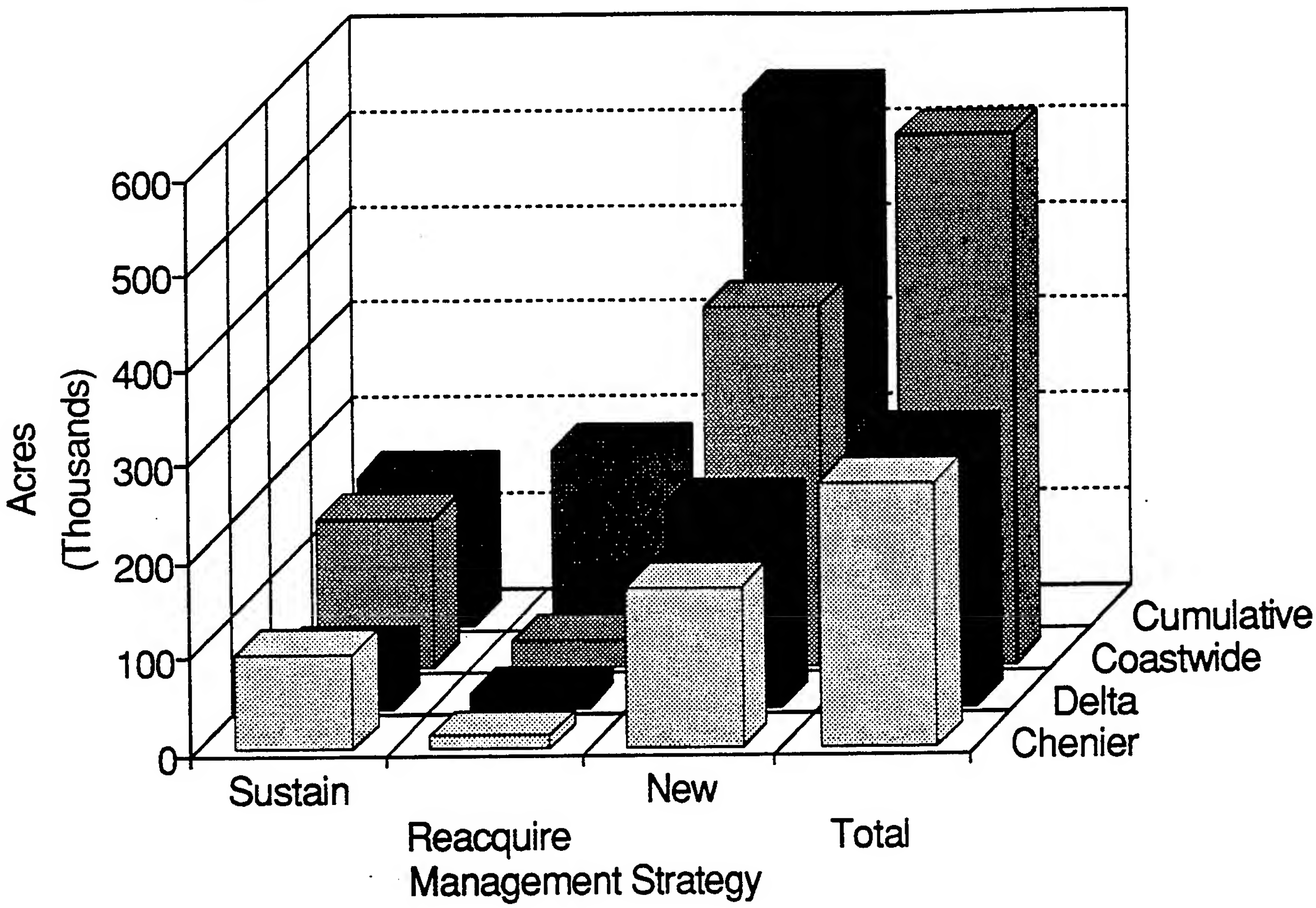


Figure Q-5 - CWPPRA:Future

Delta: Mgt Strategy x Included MT

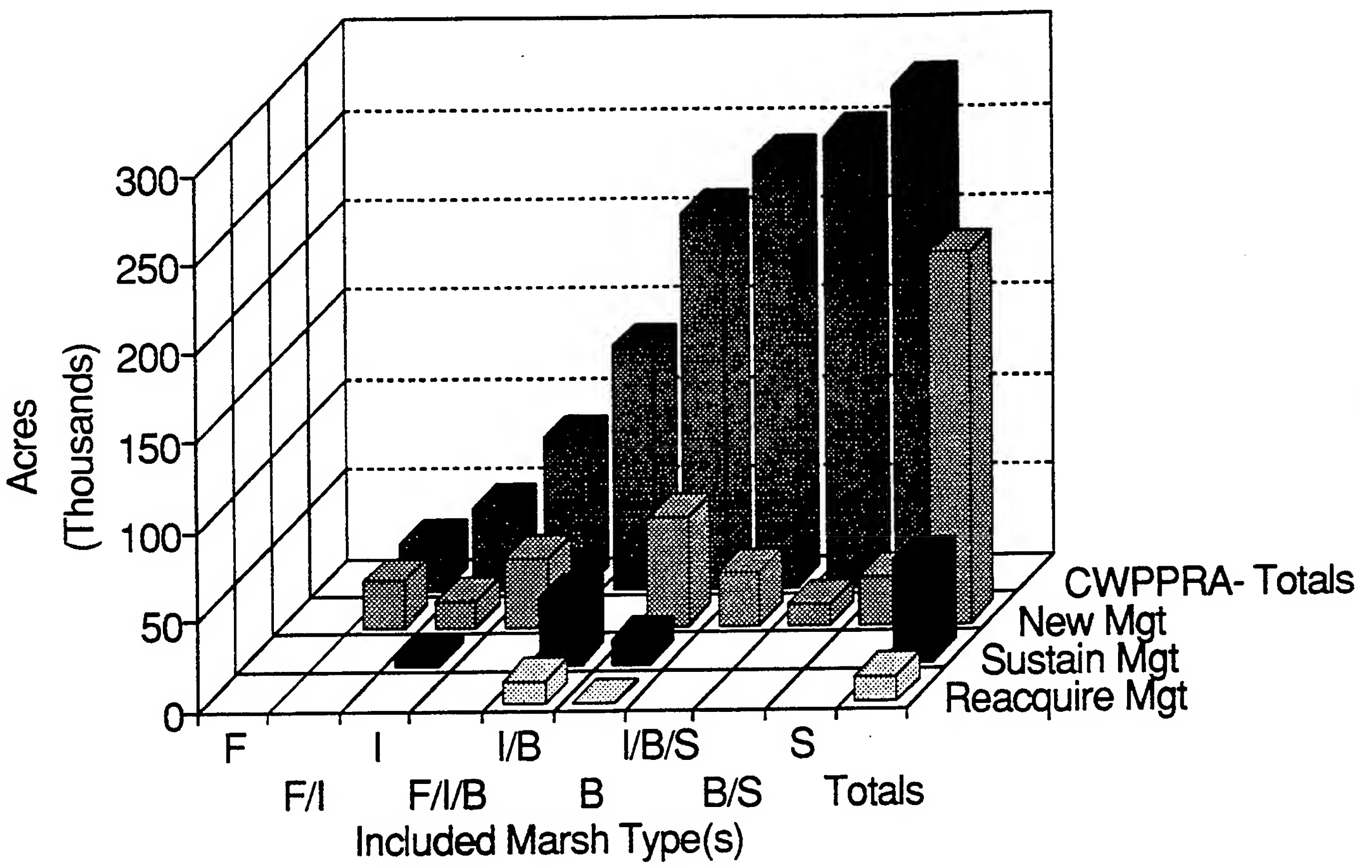


Figure Q-6 - CWPPRA: Future

Chenier Region: MT by Mgt Strategy

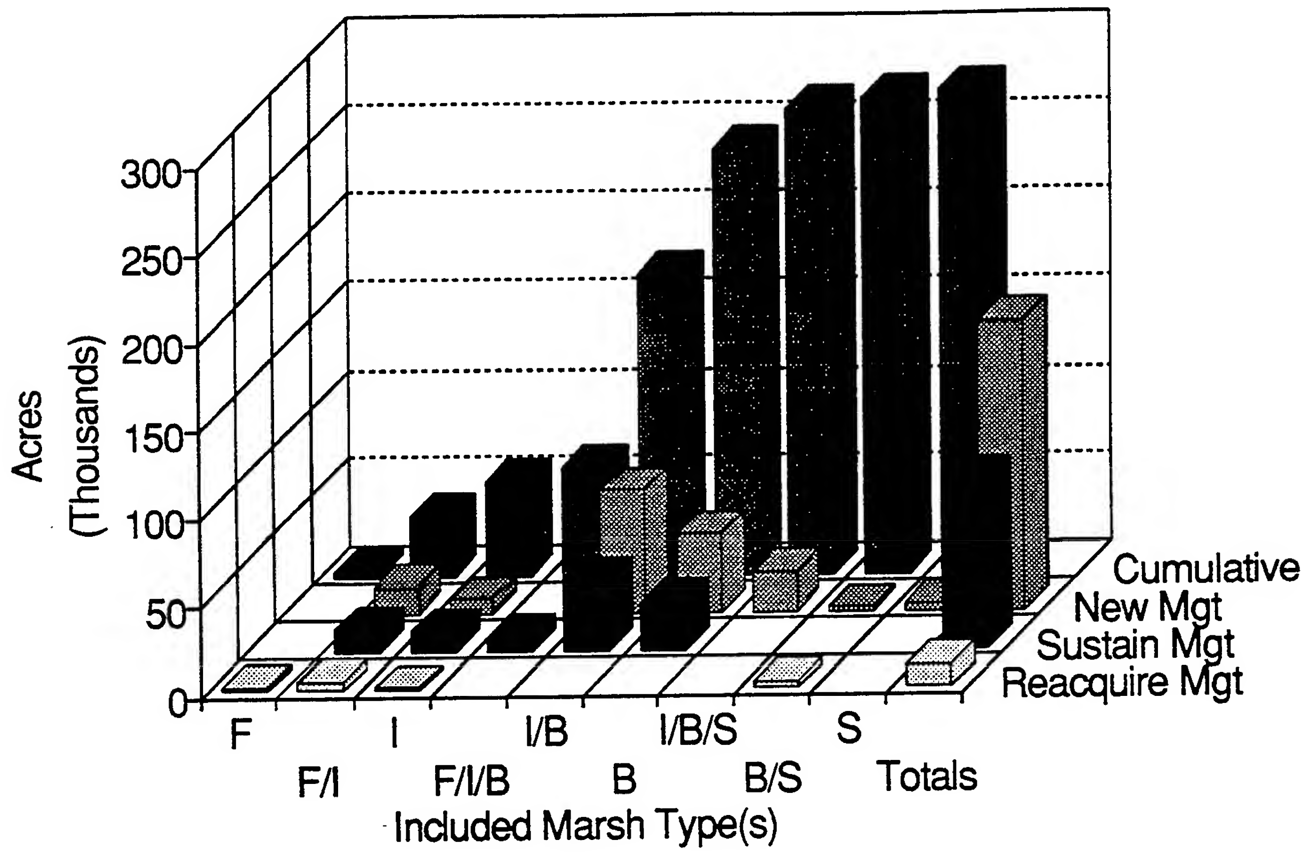


Figure Q-7 - CWPPRA: Future

Coastwide: MT by Mgt Strategy

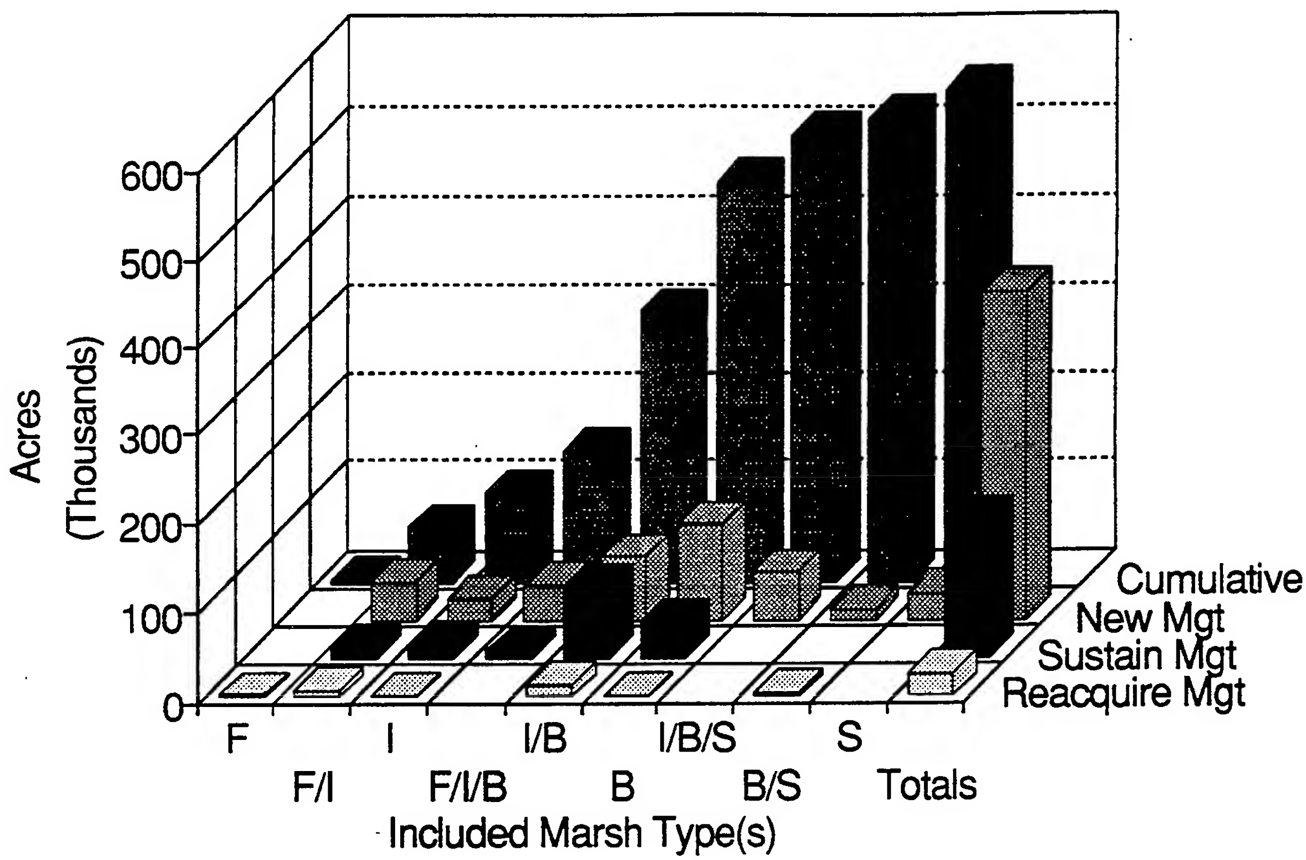


Figure Q-8 - CWPPRA:Future

Basins/Regions by Mgt Strategy

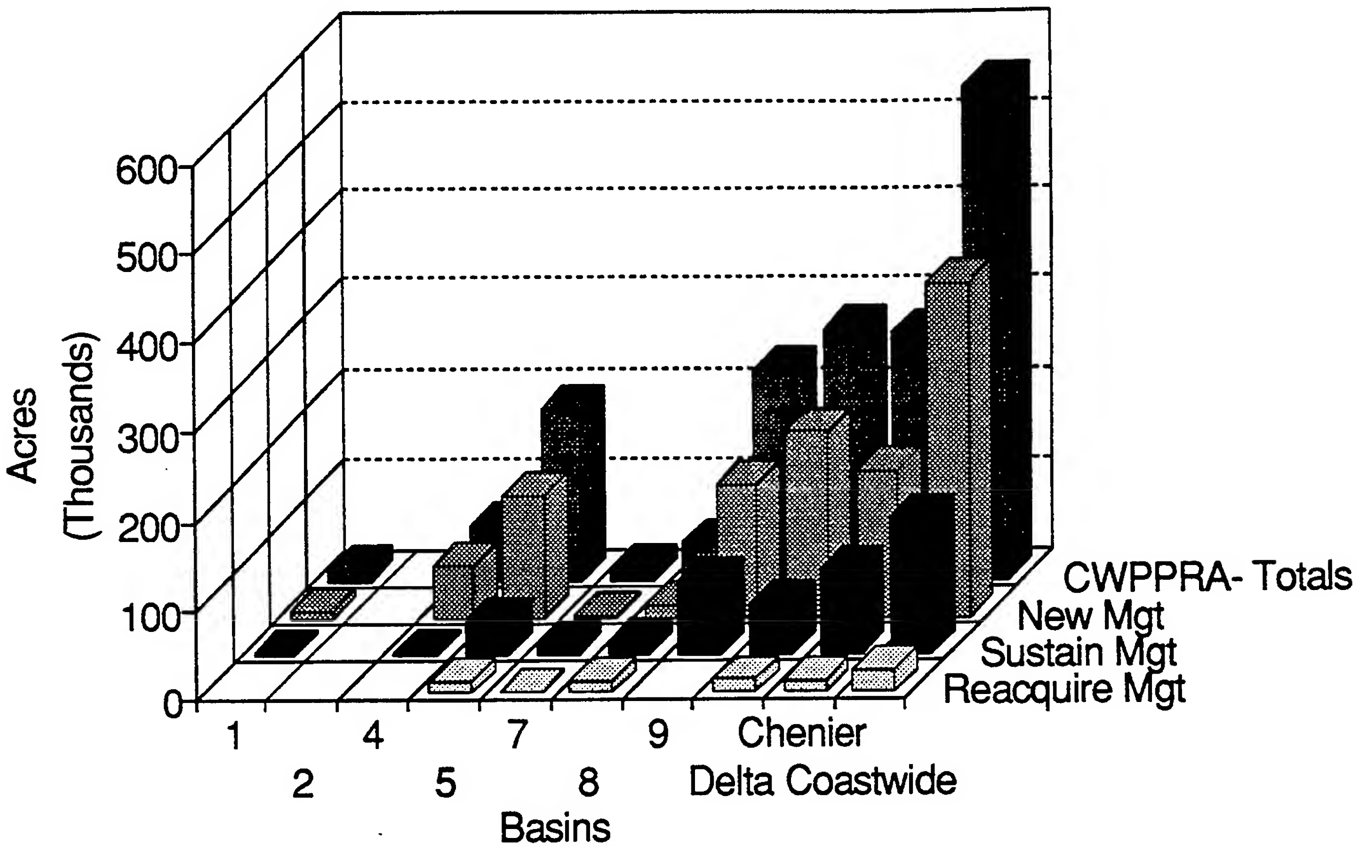


Table Q-18: Permits & CWPPRA by Included Marsh Type(s)

Permits

	Basin 1	Basin 2	Basin 4	Basin 5	Basin 7	Basin 8	Basin 9	Delta totals	Chenier totals	Coastwide totals	Permit + CWPPRA Totals	Cumul
F			12039	15679	33085	279		60803	279	61082	62832	62832
F/I				950	5140	11930	14568	6090	26498	32588	90852	153684
I				456	4258	5524		4714	5524	10238	49947	203631
F/I/B			168657			8996		168657	8996	177653	223112	426743
I/B	12640		13449	15222	7320	8700	1235	48631	9935	58566	219484	646227
B	18174	2260	7256	7714	4690	13302	2685	40094	15987	56081	201238	847465
I/B/S							66000	0	66000	66000	122499	969964
B/S			11650	804			7224	12454	7224	19678	32578	1002542
S	834		12300					13134		13134	44024	1046566
Totals	31648	2260	225351	40825	54493	48731	91712	354577	140443	495020	1046566	

CWPPRA

	Basin 1	Basin 2	Basin 4	Basin 5	Basin 7	Basin 8	Basin 9	Delta totals	Chenier totals	Coastwide totals
F						1750			1750	1750
F/I				25833		27181	5250	25833	32431	58264
I	8000		3994	2400	5365	1000	18950	19759	19950	39709
F/I/B				38250		7209		38250	7209	45459
I/B				51468			109450	51468	109450	160918
B	5170		12295	48120	9278		70294	74863	70294	145157
I/B/S			18099	12200		4000	22200	30299	26200	56499
B/S				10900			2000	10900	2000	12900
S			26500				4390	26500	4390	30890
Totals	13170		60888	189171	14643	41140	232534	277872	273674	551546

Permit & CWPPRA: Basin Totals

Totals	44818	2260	286239	229996	69136	89871	324246
Cumul	44818	47078	333317	563313	632449	722320	1046566

Table Q-19: Permits & CWPPRA- Comparison of Total Acres

	Basin 1	2	4	5	7	8	9	Delta	Chenier	Coastwide
PERMITS	31648	2260	225351	40825	54493	48731	91712	354577	140443	495020
Sustain	3915		2548	38444	12062	14509	82300	56969	96809	153778
Reacquire				13024	400	12250		13424	12250	25674
New	9255		58340	137703	2181	14381	150234	207479	164615	372094
CWPRA Tot	13170		60888	189171	14643	41140	232534	277872	273674	551546
TOTALS	44818	2260	286239	229996	69136	89871	324246	632449	414117	1046566

Figure Q-9 - PERMITS & CWPPRA

Region x Marsh Type

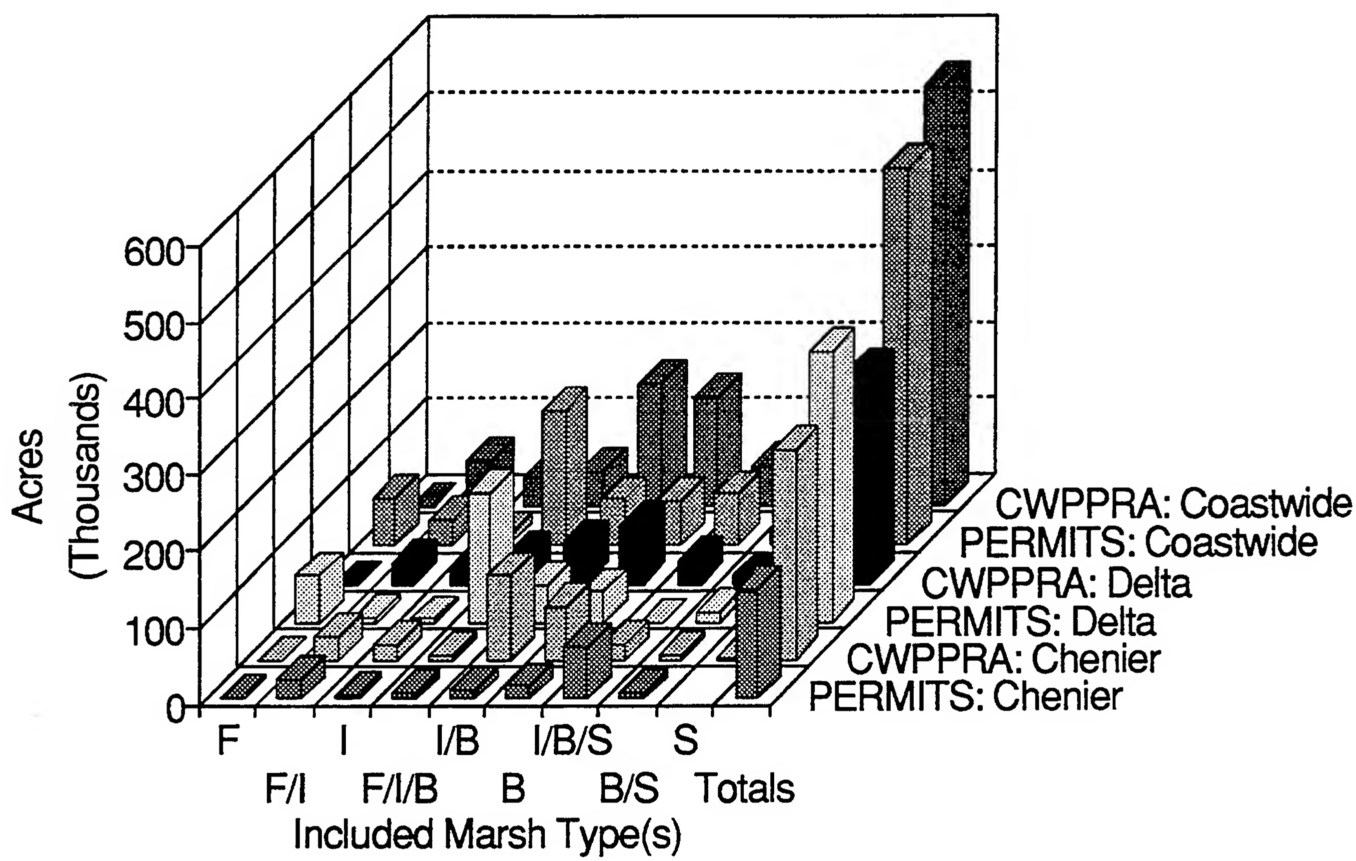
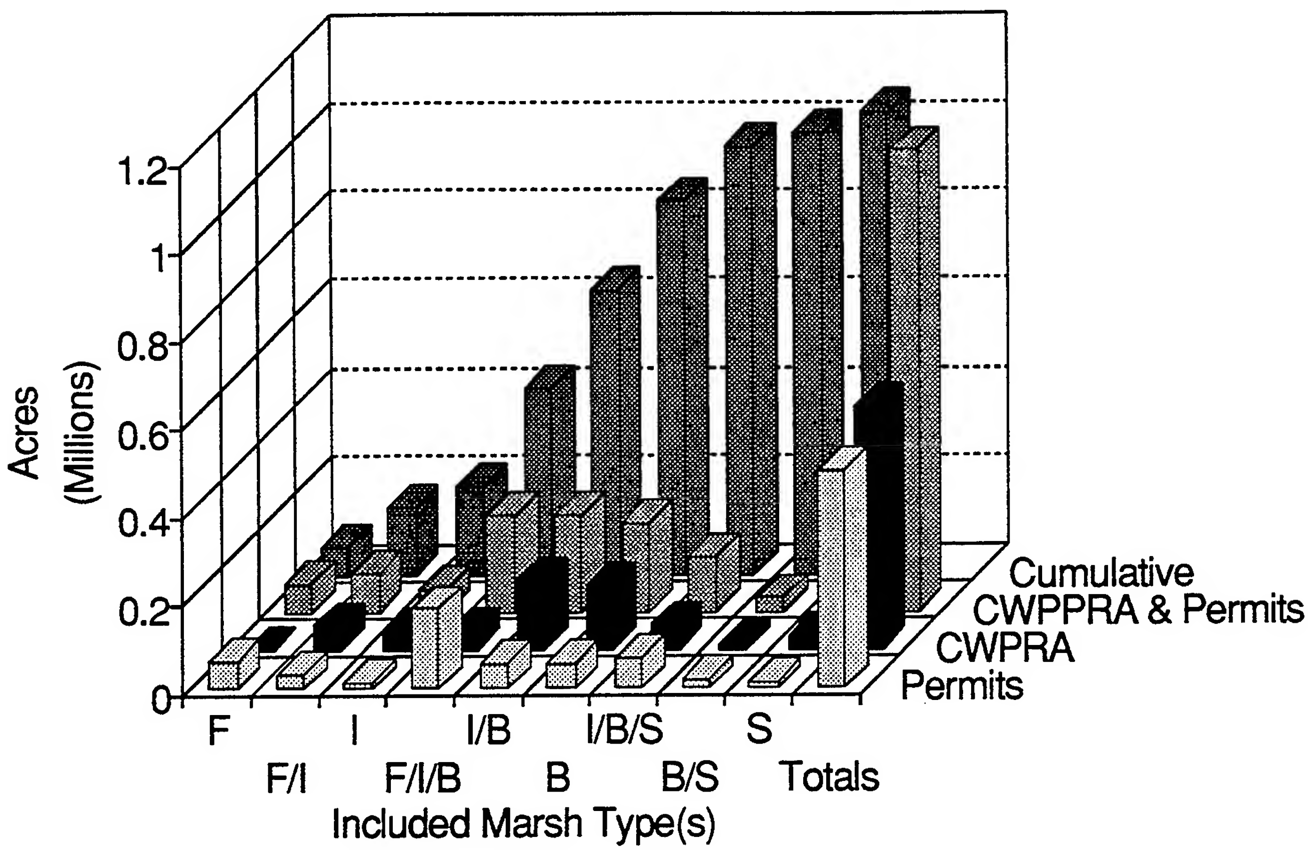


Figure Q-10 - PERMITS & CWPPRA

Total Acres Coastwide



R - Benthos

The common tie among benthic species is where they are more so than what they are or do. Oysters are and crabs and shrimp can be considered are members of the benthos. They are notable as much for their ecological interest as their commercial and recreational value.

Some of the species are recreationally and commercially important directly to man. Other functions of some of these organisms can be inferred by examining feeding modes. Some benthic species tend to either filter food suspended in the water column or by nonselectively ingesting bottom deposits. Suspension feeders tend to occur more often in sandier-bottom areas whereas deposit feeders tend to occur more often in areas with siltier, more organic-rich bottom materials. Species in both groups tend to reside in the sediments. Other suspension feeding species group together on top of the water bottom. Grouped feeders slow current velocities, thereby possibly encouraging sediment deposition. Many if not all are food for some other organism. For example, many are food items for fish and migratory and resident wading and shorebirds.

Buried suspension feeders (e.g., clams), as well as group suspension feeders (e.g., oysters) extend siphons, actively draw in and filter water, extracting food (e.g., suspend detritus - with its community of associated bacteria, fungi, zooplanktors, phytoplankton), and pump-off the filtered water back to the water column. The generally immobile suspension feeders depend upon a supply of food carried to them by water movements. Oysters can extract up to eight times their own weight each day. Along with other suspension feeders they can have effects on turbidity, and nutrient cycling.

Deposit feeders ingest organic-rich sediments, either through siphons or while burrowing. They also derive their energy by digesting the ingested organic detritus as well as associated living tissue.

Both groups repackage organic matter. Buried species enrich the soil profile with their particulate excreta while suspension feeders enrich the soil surface.

Another group of benthic organisms includes species that displace sediment particles as they burrow through the bottom materials. Different species assemblages occur within muddier soil profiles compared with sandier soil profiles. Regardless, burrowing increases exchange of water, oxygen and nutrients with the upper reaches of the soil profile and also increases the organic content of the soil profile. In Barataria Bay, Louisiana nematodes occurred only within the top inch or two of the soil surface. To what extent species

may penetrate and are able to persist in soil conditions lacking oxygen in Louisiana's managed and unmanaged marshes is an interesting question. Soil temperature may seasonally influence numbers because from Florida marshes at similar latitudes species from this group exhibited peaks during November and December.

A heterogenous benthic group includes highly mobile forms such as the shrimps and crabs. Those species could just as easily be perceived to be part of the planktonic or fish communities of the marsh but their feeding and other behaviors are linked to pond bottoms and marsh soils. These organisms actively burrow into the substrates to acquire shelter and/or food, graze food from surficial deposits, scavenge, and are themselves food items for other organisms, including man. The growth and breeding physiology and movement patterns of these species are influenced by water temperatures, salinities, and water movements, on daily, monthly and seasonal scales.

If quantitative studies comparing the structure and function of the benthic communities in managed and unmanaged Louisiana marshes have been performed, they are not readily retrievable. However, the average grain size, organic matter content and soil bulk densities are attributes of marshes that influence benthos. Marsh and open water/pond soils differ within and between basins and, therefore between regions and throughout Louisiana's coastal marshes exhibit differences in those same attributes. Corresponding patterns of benthos can be expected.

Day et.al. (1973) reported that the biomass of some benthic species was greater near the waters edge in a Barataria Bay, Louisiana, salt marsh. Thus, moving the waters edge down the slope of exposed sediments by lowering water levels for prolonged periods on a repetitive basis would likely have a different effect than just stabilizing water levels at or near the natural marsh edge. The biological significance of any such differences between the alternative water management options and unmanaged marsh probably remains to be quantified in Louisiana.

However, the diversity of species and sheer numbers of individuals of the benthic species that can and do reside on or in the soils of ponds and marshes argues for some degree of stability in the dynamic environment of a marsh.

Field data collections by Coull (1986), Wenner (1986a,b) and Olmi (1986) in South Carolina are suggestive of the potential for differences between managed and unmanaged marshes. All five managed ponds existed on the same tidal creek. Water level were drawn down but not identically.

These investigators recorded and compared changes that occurred in the numbers of benthic meiofaunal (from Sept 1982 and February 1983 - Coull, 1986), benthic macrofauna (during six selected two-day periods from January to July 1984 - Wenner 1986a), and decapod crustacean populations (regularly from January 1983 to December 1984 - Olmi; alternate months from March 1983 to December 1984 - Wener 1986b) in impoundments (that underwent water level drawdowns during May of 1983 and October and November of 1984; Coull, Wenner 1986a), at impoundment structures, to include a drawdown (Omni), and an adjacent tidal creek in unmanaged marsh (all).

Coull (1986) recorded the same species groups in managed ponds. However, the number of individuals per group between ponds was significantly different. Based upon a single sampling date in February, Coull recorded more species represented in unmanaged sites but recorded differences were not statistically significant. Variation within ponds precluded any definitive finding relative to substrate differences encompassed within managed ponds. He commented that the species assemblage in impoundments was similar to what occurred on high intertidal marsh in South Carolina. With only two sampling dates and because hydrologic integrity was lost in several ponds on separate occasions, Coull rightly characterized his results as preliminary.

Wenner (1986a) recorded statistically significant differences between and within ponds and between ponds and unmanaged areas. Despite the loss of hydrologic integrity in several [ponds on separate occasions, impoundments exhibited species assemblages different from unimpounded sites and fewer species. Animal differences were correlated with physicochemical (concurrent data collection) differences between managed and unmanaged areas. He concluded that animal differences were the result of a more physically stressful condition in the managed ponds that resulted from the water management regime as dictated by the management objective (i.e., foster the growth of widgeon grass), even when flow through was permitted. He postulated that predation effects could play as an enhanced role in structure benthic communities in the managed ponds.

Omni reported experiencing several experimental design problems that resulted from the design and operation of the water control structures. The consequence was reduced exchange and, therefore, reduced data collections. However, the design problems highlighted the basic findings of his study. He concluded that,

> "Utilization of the impoundments by target (shrimp and crabs) organisms was dependent on water exchange between Chaney Creek and the impoundments to provide access to

the impounded area.....The degree to which a particular species was able to inhabit the impounded areas depended upon the timing of recruitment of that species and periods of water exchange between Chaney Cree and the impoundments."

The appearance of juvenile planktonic forms at the creek side of the water control structures followed seasonal life history patterns. However, water management schedules appear to be able to impart an unintended access bias advantageous more so to spring migrants and disadvantageous to later season migrants.

Wenner focused on characterizing decapod crustaceans from natural and impounded wetland areas. To facilitate his comparison, he pooled data from impoundments. By using pooled data, he statistically equated impoundments, despite the loss of hydrologic integrity on several ponds on separate occasions and some differences in water management regimes between ponds. In effect he measured something more like a "net" response over a range of natural and man-made situations managers of impoundments might encounter. In that unintended context, he reported that managed and unmanaged areas were similar in many respects (species composition, temporal patterning), but also exhibited differences. Differences suggested by his data were that structures and management regimes imposed access and retention selectivities of blue crabs and Penaeus shrimp.

These same conclusions would seem to apply to some degree fairly well to managed Louisiana marshes.

S - Comments and Responses

Appendix S Consists of three parts.

S.1. Tabular comparison of the D-PHMEIS and F-PHMEIS relative to comments received.

S.2. Response to comments received from co-operating Federal and State agencies.

S.3. Response to comments received from the general public.

Note: "Chapters" and "Sections" refer to identified portions of the F-PHMEIS.

S.1. Tabular comparison of the D-PHMEIS and F-PHMEIS relative to comments received.

Item	D-PHMEIS	F-PHMEIS
Executive Summary	Not included, necessary	To be included, being written
Introduction (Chapter 1)		* Terminology/new title alerts reader to focus on hydrologic management
Purpose & Need (Chapter 2)	Reason for writing and utility of document unclear	* Rewritten & reorganized * Added section about what document does & doesn't do * Moved definitions to here
	Reliance on CWPPRA too great/too little	* More detailed explanation of why CWPPRA was included
	Eliminate HR/expand to include all CWPPRA project types	* Defined HR * Included detailed explanation of why HR was included * Screened all CWPPRA MM and HR for inclusion/exclusion * Did not include in our analysis projects eliminated by CWPPRA from basin restoration plans
Alternatives (Chapter 3)	CWPPRA is inappropriate future condition	Expanded narrative of applicability to NOD's EIS effort- a) gives footprints b) gives spatial associations c) gives project acreages d) identifies included marsh types e) profiles problems requiring management f) product of extensive public involvement effort versus
	Use NOD's permit data base	NOD having to make assumptions about all of the above from a sparse data base (creates issues that aren't there if CWPPRA is used)
	NOD ducked legal/policy issues	* Expanded discussion- a) reemphasizing role in legal matters, b) an EIS is disclosure not policy document

Settings & Significant Attributes (Chapter 4)	Instructive tone and depth of detail in main text is unnecessary and intimidating	* Moved much of the instructional, detail and background material to appendices- narrowed focus and improved flow & readership
	Too repetitive	* Resequencing and blending/merging and cross-referencing between subordinate heading created larger subject areas of discussion that: a) improved readership & flow, and b) reduced length
	Permit data too presumptive/inaccurate regarding construction status	* Permit follow-up significantly improved accuracy
	Permit data unreflective of monitoring	* Narratives and tables updated- a) showing construction status - (issuance ≠ initiation ≠ complete installation) b) monitoring requirement and compliance
	Permit data not informative	* Created profiles of permitted, initiated, completely installed projects
	Permit analysis a) appears cursory	* Performed follow-up, narrative and analyses based upon data acquire from that effort * Permit data tables amended to show: a) if permit monitoring required b) if report submitted
	b) does not speak to monitoring/compliance	* Text now includes permittee profiles relative to purpose and need, project status and monitoring compliance
	Improve readership and understanding	* Greater reliance upon motivation of reader to conduct own follow-up by putting much in the appendices For example, moved species group narratives to appendices * Significant attributes narratives restructured/shortened- summary presented first followed by "basis" * Stressed interrelationship between significant attributes at each opportunity (reinforces theme of interactive relationships characterize/define structure and function of marshes) * Wrote individual narrative summaries for physicochemical, biological and socioeconomic significant attributes * Created a Regulatory Implications narrative * Corrected or amended as per comments, subsequent discussions
	Technical inaccuracies (eg, terminology, concepts)	* Expanded citations in text * Revised: more on-point and impact/effect oriented
	Socioeconomic narrative was too nebulas	* Reliance on available info still reads as largely speculative because expansion too time consuming and expensive
	Multiple objections to Table 4 (a comparison of MM and HR)	* Eliminated. Felt objections focused on project titles. Therefore, coined term Hydrologic Management- an umbrella term encompassing AMM, PMM and HR- to force focus on impacts and effects.

Impacts & Effects (Chapter 5)	Depth of detail in main text is unnecessary and intimidating	* Greater reliance upon motivation of reader to conduct own follow-up * Moved detailed and modified profiles of candidate CWPPRA projects to appendices * Replaced in main text by basin, regional and coastwide summaries. * Additional merging of significant attributes
	Table 5 too detailed, too hard to follow	* Eliminated. Felt objections an extension of project title biases, and structure of table.
	Improve readership	* Much greater focus on impacts and effects, including recognition and discussion of incomplete project implementation, and contribution of candidate CWPPRA projects
	Conclusions not always well supported, specifically argument for case-by-case permit evaluations	* Additional citations and more in-depth subject matter development
Other Comments/Issues		
Impacts to Fisheries	Alleged to be under represented	A matter of perspective. Revisions better reflect biological and socioeconomic linkages
Policy Implications	Does not speak to policy other than a reference to continued case-by-case analyses	A disclosure document only. Not required by regulation. General policy-type statements could evolve in a parallel or subsequent effort. However, any such effort would not, because it legally could not, stipulate 'inviolate issuance/denial situations.'
Consistency with CWPPRA	As per recently published documents	In-house reviews and updates
Maps	Show additionally managed areas for context	Redrawn for both permits and CWPPRA, but could not delineate 'other' managed areas objectively.

S.2. Response to comments received from co-operating Federal and State agencies.

S.2.1. Cooperating Federal Agencies

S.2.1.1. U. S. Department of Agriculture, Natural Resources Conservation Service (NRCS)

1. Disagree to addition, it has no foundation in the document.

2. Amended

3. Amended

4. Disagree, should not be the case by the time the permit decision is rendered.

5. Section 4.1. and 4.2. are responsive.

6. Disagree, not always the case (See Section 5.8.)

7. Noted, see Chapters 2.0. and 3.0.

8. Amended, see Section 3.2.3.

9. Noted, see Section 3.2.

10. Noted, see Chapter 3.0., especially 3.2.2

11. Agree, see Section 3.2.1.

12. See 11.

13. Inappropriate for this section of the F-PHMEIS.

14. The issue is addressed in 4.3.6.8. as per the matters brought out in the public scoping meetings.

15. Agree, see Section 1.2.3.1.

16. Agree, see Section 1.2.3.2.

17. Noted.

18. Disagree, would be redundant.

19. Eliminated, see Section 2.3.3.....eliminated "But" to reflect changes in the concept of marsh management.

20. Agree, see Section 2.3.3.

21. Disagree, see revised section 2.3.6.

22. Clarified, see Section 2.3.6.

23. Noted, see Section 5.1. and Tables C.1.-C.8.

24. Noted, corrected throughout F-PHMEIS.

25. Sections 4.2.2. And 4.2.3. are responsive.

26. Noted, see Section 2.3.4.

27. see 26.

28. Noted and corrected.

29. See Appendix A.

30. Noted, see Section 4.3.4.1.2.

31. See Appendix A.

32. Agree, correction made.

33. Agree, see Section 4.3.2.

34. Noted, see Section 2.3.8.

35. Disagree, not to point of paragraph, but see 4.3.4.1.2.

36. See Appendix D.

37. Amended, see page 4-31.

38. See Appendix D and Section 5.1.1.5.2.2.

39. See Appendix D, "surface" is not needed.

40. Noted, see page 4-31.

41. Section rewritten, see Section 4.3.3.

42. Section rewritten, see Section 4.3.5.2.7.

43. Amended, see Section 4.3.5.4.2.1.

44. Noted, see Section 4.3.5.2.4.

45. Rewritten, see Sections 4.3.5.2.4.1. and 5.5.2.4.

46. Noted, see Section 5.5.2.5. and Appendix F.

47. Amended, see Section 4.3.5.2.4.2.

48. Amended, see Section 4.3.5.2.4.3.

49. See 40.

50. Disagree, out of context relative to surrogates

51. Noted, see Section 5.3.3.

52. Disagree, properly represented as presented.

53. See 52.

54. Elected to retain the original presentation.

55. Rewritten, see Sections 4.3.4.3.1. and 4.3.5.3.1.

56. Agree, see Section 4.3.4.5.1.2.

57. See 56.

58. See Section 4.3.2.

59. See Section 4.3.5.1.3.2.

60. Noted, see Sections 4.3.4.1., 4.3.4.1.3., 4.3.4.7.

61. Noted, see Section 4.3.5.1.3.2.

62. Corrected.

63. Noted, but meaning is clear.

64. Rewritten, see Section 4.3.5.1.3.2.

65. Noted, see Section 4.3.4.4.1.

66. Noted, see Section 4.3.5.1.4.

67. Corrected.

68. Redundant, tidal export is the erosive mechanism.

69. Rewritten, see Section 4.3.5.2.3.

70. Noted, see Section 4.3.5.2.4.

71. Noted, see Section 4.3.5.2.4.1.

72. see 71.

73. Noted, see Section 4.3.5.2.4.2.

74. see 73.

75. see 65.

76. Rewritten, see Section 4.3.4.1.1.

77. Rewritten, see Section 4.3.4.1.2.

78. See 77.

79. Passage eliminated.

80. Noted, see Section 4.3.4.1.3.

81. See 80.

82. See 80.

83. Noted, see Section 4.3.4.1.3.2.

84. Amended.

85. Noted, amended, see 83.

86. Disagree, see amended Section 4.3.6.1.

87. Corrected.

88. - 94. Corrected.

95. Disagree, already stated caution.

96. Corrected.

97. Corrected, see Section 5.5.1.5.

98. Passage eliminated.

99. Rewritten, see Section 5.5.2.1.

100. Corrected, see Section 4.3.5.2.2.

101. See 100.

102. Noted, see Section 4.3.5.2.5. and Appendix G.

103. Noted, see Section 5.5.3.4.

104. Noted, see 4.3.6.2.1.1.

105. Noted, see Section 4.3.6.2.2.

106. Rewritten, see Section 4.3.6.6.

107. Rewritten, see Section 4.3.6.9.

108. Noted, see Section 4.3.6.11.

109. Noted, see Section 4.3.6.8.1.

110. Disagree, proposed amendment appears to be an unsubstantiated opinion.

111. Rewritten, see Section 4.3.6.14.

112. Noted, see Section 4.3.6.18.

113. - 125. Table 4 eliminated. See corresponding discussions of significant attributes in Chapters 4 and 5.

126. Noted, see Chapter 3.0.

127. The candidate CWPPRA HM projects were reviewed by Ms. Sue Hawes (see Chapter 7.0.). See also Appendix Q.

128. Rewritten, see Section 5.2.1.1.

129. Not applicable, **PO-6** no longer included (see Appendix Q).

130. See 129.

131. Agree, see Appendix Q.

132. Disagree, accurate as presented.

133. Corrected.

134. Amended, see Appendix Q.

135. See 134.

136. Disagree, accurate as presented- salinity is not untoward and revegetation can be non-existent for several other reasons.

137. Disagree, suggested change not to point.

138. Corrected.

139. Noted, but goes to future viability of HM.

140. Disagree, accurate as presented, see Appendix D.

141. Noted, goes to continuing role of CWPPRA participants.

142. Disagree, accurate as presented, se Q-8.

143. Deletion made, but didn't include "benefits" statement as it is misplaced.

144. Amended, see corresponding narrative.

145. Noted, see Sections 5.2.1.3. and 5.2.3. and 5.5.1.5.

146. Passage eliminated.

147. Noted, see 145.

148. Disagree, true and to point as presented.

149. See 5.3.3.

150. Noted, see 5.2.1.3.

151. **PTE-26** no longer included.

152. Corrected, but disagree with proposed acreage, see 139 and 141, which reinforces decision to include candidate CWPPRA HM projects.

153. Disagree, see Appendix D.

154. Corrected.

155. Amended, see Appendix Q.4.

156. Disagree, accurate as presented.

157. See 155.

158. Disagree, not to point.

159. See 155.

160. See 155.

161. Noted, true as stated but see Section 5.2.2.2.

162. Corrected.

163. Disagree, not to point see Section 5.4.

164. Noted, redundant, see 149.

165. See 150.

166. See Appendix D.

167. - 168. Disagree, true as stated.

169. Corrected.

170. See 167.

171. See 131.

172. See 167.

173. Corrected.

174. See 131.

175. Corrected.

176. See 131.

177. Rewritten, see Section 5.2.1.5.

178. See 177.

179. Disagree, not to point.

180. Noted, all would be evaluated if pursued further.

181. - 182. See 131.

183. - 184. Corrected.

185. Noted, see changes at Q-22.

186. See 131.

187. Corrected.

188. See 131.

189. See Q-24 for changes.

190. Presumptive, see Appendix D.

191. Disagree, accurate as presented.

192. - 193. Eliminated.

194. See 131.

195. Noted.

196. Noted, goes to continuing interest in CWPPRA HM projects.

197. Disagree, accurate as stated.

198. True as stated, but amended.

199. See 131, but retained for clarity.

200. Disagree, accurate as stated, but also represents difference of opinion about site-specific losses.

201. Amended.

202. - 204. See 131.

205. Disagree, accurate as presented.

206. See 131.

207. Noted, redundant, see page Q-29.

208. See 131.

209. - 210. See 1st paragraph on page Q-30.

211. See 131.

212. see 209.

213. Disagree, accurate as presented.

214. - 215. See 131.

216. No change, self-evident.

217. See 131.

218. No change, self-evident.

219. See 131.

220. Disagree with acreage and representation of included features.

221. No change, better image as presented.

222. Noted.

223. Corrected.

224. See 220.

225. - 229. See 131.

230. No change, self-evident.

231. See 131.

232. No change, self-evident.

233. Disagree, accurate as presented.

234. No change, self-evident.

235. Change made.

236. Refers to multiple areas, retained for clarity.

237. Importance of suggested change not clear.

238. Corrected.

239. Noted, retained for clarity.

240. Corrected.

241. Noted, retained for clarity.

242. No change, suggested change conflicts with NRCS's (SCS) River Basin Report.

243. - 244. See 131.

245. Disagree with acreage.

246. See 243.

247. See 131.

248. See changes at Q-38.

249. See 243.

250. Disagree, because of the internal position of the parcel.

251. See Section 5.8., # 6.

252. See Section 4.4.2.2.

253. Section rewritten, see Section 4.4.2.2.2.

254. Rewritten, see Section 5.3.2.2.

255. Noted, see Section %.2.2.2.

256. No change, change not to point.

257. Corrected, see Section 5.2.2.3.

258. Disagree, see Section 5.2.3.

259. Disagree, quantitative.

260. Disagree, accurate as presented (see Section 5.2.3.).

261. Disagree, has yet to be determined.

262. Rewritten, see Section 5.2.3.

NOTE: Table 5 has been eliminated.

263. Noted, see Section 4.3.5.1.3.1.

264. See 264.

265. - 266. Noted, See Sections 4.3.5.1.3.2. and 5.5.1.

267. - 268. Noted, no corresponding section in table, but see Section 5.5.1.

269. Noted, see Section 5.8

270. Noted, see Section 5.5.1.

271. Amended, see Sections 4.3.4.1.4. and 5.5.1.

272. See 272, and Section 5.8.

273. Noted, see Section 5.8.

274. - 276. Disagree, self-evident, see Sections 4.3.4.4. and 5.5.1.

277. Disagree, see Sections 5.1. and 5.8.

278. - 279. Disagree, see Sections 4.3.5.2.3. and 5.5.2.3.

280. - 281. Suggested change presumptive, see 279.

282. Noted, see Sections 5.8.2., # 3 and # 6.

283. - 285. Suggested change appears to be an over representation considering brackish marsh, see also Sections 4.3.5.2.4. and 5.5.2.4. - 5.5.2.9.

286. Noted see 299.

287. Appears to conflict with public access as addressed in 4.3.6.8.

288. See Section 5.3.3. and 1.

289. Unclear, comment could refer to semi-impoundments as well as complete impoundments.

290. Noted, see 5.3.3. and 5.4.5.3.

291. Comment not to point, the acreage referred to was subjected to MM.

292. - 294. Noted, mimicking some unstipulated natural (= historic) hydrologic conditions is a means to an end, not a project purpose or need.

295. Corrected.

296. - 297. No change, not to point/context.

298. The "current" condition has become the natural condition - see Chapter 3.

299. - 301. Noted, address the issue of beneficial use of dredged material, not HM.

302. Noted.

303. See 287 and 299.

304. Noted, but was self-evident from other part of table.

305. See 287 and 299.

306. Noted, see Section 5.3.3.

307. Rewritten, see Section 5.8.1.

308. See 52 and 53.

309. Corrected.

310. Noted, no change, a statement with policy implications.

311. Amended, see Section 5.6.2.1.

312. - 315. Corrected

316. - 323. NRCS included.

324. Noted, see Appendix D.

325. NRCS process included as Appendix M.

326. Noted, not essential.

327. For clarity and to indicate information sources.

328. Disagree, apparent terminology differences, but clearly defined for purposes of the appendix.

329. No change, not to point of Appendix, requested information presented a Section 4.3.4.5.1.

330. - 331. Amended, see F-5.

332. Amended, see H-2.

333. Amended, see H-4.

334. Noted, see 4.3.6.2., speaks to the difficulties of quantifying the monetary linkages of commercial fisheries.

335. Point of comment eludes us.

336. Section rewritten, see Sections 4.3.6.2.1. and 5.6.7.

337. - 338. Seems unnecessary, see Section 4.3.6.2.1.2.

339. - 340. Rewritten, see Section 4.3.6.2.2.1.

341. Disagree, retained, see Section 5.6.2.2.

342. - 343. Rewritten, see Section 4.3.6.3. and 5.6.3.

344. - 347. Rewritten, see Sections 4.3.6.4., 4.3.6.5., 4.3.6.8., 5.6.4., 5.6.5 and 5.6.8.

348. Amended, see Section 5.6.10.

349. Rewritten, see Sections 4.3.6.11 and 5.6.11.

350. Disagree, part of the "evolutionary process", see also Sections 4.3.6.12. and 5.6.12.

351. See Appendix I.

NOTE: Appendix M in D-phmeis is Appendix B of F-phmeis.

352. Disagree, accurate as stated.

353. - 354. Not to point, and accurate as presented.

355. Amended, see Appendix B.

356. Noted, see Appendix B.5.

357. Noted, see Appendix B.6.

358. Disagree, on point and accurately presented.

359. Amended, see Appendix B.

360. Corrected.

361. Comment is incomplete, but appears to be a matter of professional opinion.

362. Corrected.

363. Disagree, presumptive, no foundation in document.

364. No change, redundant, see paragraph 3 on page B-11.

365. Disagree, see Section 5.1.1.

366. See Appendix G.

367. Not included, redundant, already addressed in draft and final documents.

United States
Department of
Agriculture

Natural Resources
Conservation Service

3737 Government Street
Alexandria, Louisiana
71302

Rec'd
CELMN-
PD-RS
11/20/95
RHB

November 15, 1995

Mr. Robert Bosenberg
U.S. Army Corps of Engineers
New Orleans District
CELMN-PD-RS
P.O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Bosenberg:

Enclosed are our comments on the draft Programmatic Hydrologic Manipulation Environmental Impact Statement (PHMEIS) and Appendices. It would be more appropriate to limit the scope to what is termed marsh management and not include hydrologic restoration. If additions are felt necessary, then all of the management options such as sediment and nutrient introductions, creation using dredged or other non-native material, etc., should also be addressed.

Regarding the comments sent on July 19, 1995, for the 50% draft review, you only incorporated those that dealt with typographical errors. We feel that those comments are important and they have been included in with the current draft.

Thank you for the opportunity to review this document.

Sincerely,

Donald W. Gohmert

Donald W. Gohmert
State Conservationist

Enclosure

cc: Bennett C. Landreneau, Assistant State Conservationist/Water Resources, NRCS, Alexandria
Britt Paul, Water Resources Planning Staff Leader, NRCS, Alexandria
Marty Floyd, Wildlife Biologist, NRCS, Alexandria
Faye Talbot, Staff Leader, Field Office Project Support Staff, NRCS, Lafayette
Ron Marcantel, Acting Area Conservationist, NRCS, Crowley

PROGRAMMATIC HYDROLOGIC MANIPULATION ENVIRONMENTAL IMPACT STATEMENT AND APPENDIXES - DRAFT October 1995

USDA - Natural Resources Conservation Service
Comments compiled[*] by
Marty Floyd, Wildlife Biologist, Alexandria, LA
(In conjunction with July 19, 1995 comments)

ix Table of Contents, Appendixes - [*missing*]
ix add: *O Species or Groups of Animals of Special Concern*

1 PHMEIS-1-1, para4 - add sentence: "*However, the lesser the number of decision-makers involved in an agreement the easier it is to obtain landrights, etc. necessary for construction, and the easier it becomes to modify or fine-tune project design or manipulation. This is especially important as more knowledge is gained through monitoring efforts.*"

2 PHMEIS-1-2, para1 - [*Note: landowners and managers are a good source for historical background and they should be mentioned accordingly.*]

3 PHMEIS-1-2, para2, sent2 - "Multi-purposed management efforts are popular, *however there* ~~but so too~~ are management efforts *still* designed to manage marsh acreages for singular purposes *although this later trend is declining*."

4 PHMEIS-1-2, para3, sent1 - "The effectiveness of typical site specific solutions are poorly understood, *except by the local landowner or land manager*, and seldom comprehensively documented."

5 PHMEIS-3-1, para2, sent7 - "To be successful ... of the surrounding *altered* system." [*Management is done primarily in areas that either have been affected by man-induced hydrologic changes or are being threatened by these changes (i.e., canal construction allowing saltwater to continually encroach)*."

6 PHMEIS-3-1, para4, sent2 - Rewrite as follows: "*As with other management approaches, management objectives influenced the type and manipulation of structures however the location of these structures is determined*

[*] Loland Broussard, Civil Engineer; Gary Eldridge, Civil Engineer; John Jurgensen, Civil Engineer; Cindy Steyer, Coastal Vegeatative Specialist; Faye Talbot, Resource Conservationist

by the disruption in hydrology and the landscape of the project area."

7 PHMEIS-3-3, para1, sent2 - "Instead, NOD views marsh management and hydrologic restoration as legitimate alternatives to each other as well as several other management options ..." [*Alternatives imply that either one can be used to achieve the same objective. This is usually not the case. The primary objective in most cases is to stop or slow erosion and site-specific conditions (available water/sediment, soil types, existing modifications like canals, etc.) are what determines the best method to meet the objective.*]

8 PHMEIS-3-3, 3.2.2.2. para4, sent2 - [*More recently use of a fixed-crest weir is used more as canal lining (often at ten feet depths) to limit the continuation of tidal scour on canal bottoms, however it is still an effect management type that can be included in CWPPRA.*]

9 PHMEIS-3-3, para4, sent3 - "Thus, the "future with" ... the effects ~~existent~~ *existing* passive management ... additional passive management projects."

10 PHMEIS-3-3, 3.2.2.3. para5, sent1 - "*Like all* ~~Many~~ CWPPRA *and other projects*, hydrologic restoration and marsh management ~~projects~~ are conceptual."

11 PHMEIS-3-3, para5, sent2 - "For those projects, details about the kind, number and operational program of any installed structures would be determined during the evaluation of each individual permit request, *often this involves an interagency field trip to the site to determine if modifications are necessary prior to permit application.*"

12 PHMEIS-3-4, para2, sent2 - "Until project designs are finaalized *on all projects*, projections of project specific ..."

13 PHMEIS-3-5, 3.3.1., para2, sent2 - "Management may *or may not* accentuate them, ..."

14 PHMEIS-3-5, 3.3.1.3. Harvest - "The primary issue is ... proprietary resources. *This can be either a landowner or his representative or an individual of the "public" who takes "squatter's rights" to a particular section.* The related issue is public access *and property rights.*"

15 PHMEIS-3-8, 3.4.3.1. Burning, para7 - add sentence, after first sentence: "*Burning is also done to remove the dead, rough cover that can catch fire by lightning during dry times of the year, with resulting deep peat*

burns that are virtually impossible to put out without rainfall."

PHMEIS-3-8, 3.4.3.2. Planting Vegetation, para8, sent2 - "Whatsmore, planting ... regulated by the state or Federal government." [*Louisiana just passed legislation controlling sources, production and sale of plants in*
16 *order to protect natural existing vegetation, and federal agencies must obtain consistency determination from DNR/CMD for vegetative projects*]

17 --- {Pages PHMEIS-4-2 through PHMEIS-4-136 are labeled as DEIS-4-2 through DEIS-4-136}

PHMEIS-4-2, 4.1.2. What is management?, para4 - add sentence: "*The deliberate determination to do nothing*
18 *is also a management decision.*"

PHMEIS-4-2, 4.1.3. How is marsh management defined?, para5, sent3 - "~~But,~~ Cahoon and ..." [*Starting this sentence off with the word but gives the implication that*
19 *Chabreck's definition is incorrect. This subjectiveness should be avoided when posible.*]

PHMEIS-4-3, para.2 - "In August of 1994, the EPA defined
20 *structural* marsh management as ..."

PHMEIS-4-3, 4.1.4. Implications from the definitions, para.3, sent1 - "The definitions oblige managers ... dependent resources" [*This sentence is not always the case since many species quickly and directly benefit*
21 *from improvements on vegetative landscape. Also many, if not all, marsh-dependent resources depend on vegetation as the primary base of the food web.*]

PHMEIS-4-3, 4.1.5. Marsh erosion and marsh deterioration, para.4, sent6 - "Nyman et al ... or chemical stresses."
22 [*Need to explain the causes of this erosion*]

PHMEIS-4-9 - Add: "*4.2.2.3.4. Other wildlife Other wildlife species are also recreationally important. This includes deer, rabbit, squirrels, rails, snipe,*
23 *woodcock and doves. Separate leases may be let to allow deer hunting, or these may be lumped in with waterfowl.*"

PHMEIS-4-14, para5, sent1 - "In the late 1970's ... (now the ~~National Resource~~ *Natural Resources* Conservation
24 Service) ..."

PHMEIS-4-14, 4.3.3. Why Manage Marshes Into the Future, para.2 - add after sent3: "*Degradation resulting from*
25 *man-induced hydrologic changes that replaced historically slower meandering bayous with more water*

exchange routes can often only be resolved with structural measures that can mimic the historical conditions."

PHMEIS-4-16, 4.3.5.1.1. Passive marsh management, para.1 - add sentence: "*Passive systems can be used to slow or stop land loss, however they are usually not able to*
26 *restore lost emergent vegetation."*

PHMEIS-4-16, 4.3.5.1.2. Active marsh management, para.1 - add sentence: "*The basis for this type of system was originally the result of observations of naturally*
27 *occurring seasonal events that were able to be mimicked through structural measures."*

PHMEIS-4-18, para4, sent2 - "The level of the sea ...
28 continue to do so *(*Penland and Ramsey 1990)."

PHMEIS-4-20, para2, sent5 - "The four types occur in ~~four~~
29 bands that ..."

PHMEIS-4-21, para4 - add final sentence: "*Vegetative accretion, a large component of organic soils, is not always able to keep pace with marsh elevation, often*
30 *because of the addition of secondary man-induced actions."*

PHMEIS-4-23, 4.5.1.1 Plant Species, para2, sent4 - "Twenty-one species ... and salt *meadow(?)* grass) occurred in
31 all four marsh types (Chabreck 1972)."

PHMEIS-4-27, 4.5.4.1 Plant Species, para7, sent1 - "Oyster grass ... most abundant species (~~salt~~ *spike* grass and
32 black rush)(Chabreck 1972).*{This is in order to maintain consistency with page PHMEIS-4-23.}*

PHMEIS-4-30, 4.6. Marsh (Land) Loss, para2, sent2 - "Some factors are expressed on *short* geologic time frames
33 (e.g., decades, centuries) ..."

PHMEIS-4-30, para1, sent2 - This sentence is confusing (form of plant succession, not erosion) [*I've never heard this before, please verify*]; replace with: "*In addition, erosional forces continue even after*
34 *vegetation is converted to open water. The tidal forces, especially in organic soil conditions, continue to remove material resulting in deeper water conditions that lessen the ability for restoration and/or support for submerged aquatic vegetation (SAV)."*

PHMEIS-4-30, 4.6.3. New Marsh Erosion Insights, para2, sent1 - "Recent field studies ... from below the root zone,
35 *an important area that contributes much to plant growth necessary to maintain marsh elevation."*

PHMEIS-4-33, 4.6.4.1.1. Basin 1 - Pontchartrian, para2, sent1 - "On an annualized basis ... to open water *(GIS*
36 *analysis Britsch unpublished)*" [*add to reference list*]

PHMEIS-4-35, para1 - add sentence: "*Deltaic soils are typically more recent, organic, and therefore more fragile, once interior erosion begins these soils are more quickly transported out of the system with erosion*
37 *continuing at a fairly rapid rate until the Pleistocene material is reached (Touchet 1994).*"

PHMEIS-4-36, para3, sent4 - "~~These land loss areas coincide remarkedly well with formerly impounded and managed areas~~." [*This sentence implies that all losses occur within managed areas. One large managed area is water, however the objective of that pool is met, and it is one of the best freshwater recreational areas in the*
38 *southwestern part of the state. Other areas the geometric patterns show boundaries of managed areas, however the eroded marshes are what is outside the boundaries not within.*]

PHMEIS-4-36, 4.6.4.3. Louisiana Coastal Zone Summary, para4, sent4 - "These trends suggest ... and that *surface* land loss rates in general have slowed over the last 10 to
39 15 years."

PHMEIS-4-38, para2 - add sentences: "*Touchet (1994) discusses the formation of soils in coastal Louisiana. The USDA Natural Resources Conservation Service has soil surveys for all coastal parishes (some currently*
40 *in print and others being updated) that contain more detailed information.*"

PHMEIS-4-39, para4, sent4 - "Apparently the kinds of structures used for management *may* play a role in any differences that may develop, *as will soil conditions,*
41 *proximity to canals, climatic conditions and trends and other factors.*"

PHMEIS-4-40, para3, sent2 - "However, based upon Louisiana studies, long-term data ... managed and unmanaged marshes, *to lesser or greater effects. The exact amount of these effects is not fully know and studies are*
42 *often contradictory in findings. This however may be a result of the short-term nature of most studies.*"

PHMEIS-4-40, para4, sent1 - "Life history details ... are *only* ~~generally well~~ known in broad terms, *however Dundee and Rossman (1989) have provided the most*
43 *current information available.*"

PHMEIS-4-40, para4, sent4 - "A comparatively few reptile and amphibian ... in the brackish *marshes*, and *no*
44 *amphibians are found in* saline coastal marshes ~~types~~."

PHMEIS-4-40, para4, sent6 - "~~However~~, Based upon their
45 physiological ...nesting/resting areas."

PHMEIS-4-42, para1, sent2 - "Migrating shorebirds ... water
46 level *manipulations (Helmers 1992)*."

PHMEIS-4-42, para1, sent3 - "Passerine usage ... by the presence of shrubs or trees *on adjacent spoil banks*
47 *(Olsen and Noble 1976)*."

PHMEIS-4-42, para3, sent5 - "Cattle grazing ... to manage marshes, *however it has a beneficial effect on other*
48 *species in the chenier plain (***Ross 1995***)*."

PHMEIS-4-44, para2 - add sentence: "*Touchet (1994) discusses*
49 *formation of soils and therefore their erodability.*"

PHMEIS-4-51, para3, sent3 - "However, those surrogates can be highly variable, *yet this habitat is recognized as critical according to the U.S. Fish and Wildlife*
50 *Service's North American Waterfowl Management Plan.*"

{Did not closely examine 4.8.3.1. Delta Region/Basins, PHMEIS-4-52 through 4.8.2.3. Chenier Region/Basin Summary, PHMEIS-4-75}

PHMEIS-4-80, para1, sent2 - "CWPPRA monitoring is capable of addressing many if not all of these attributes, *this monitoring will allow modifications to permitted*
51 *schemes to fine-tune the process in order to more effectively achieve objectives of projects.*"

PHMEIS-4-80, para6, sent5 - "The physico-chemical setting in
52 South Carolina is *far from* ~~not~~ identical."

PHMEIS-4-80, para6, sent6 - "And, the management structures and schedules are *also quite different* ~~not identical~~
53 ~~either~~."

PHMEIS-4-80, para6, sent7 - "Nonetheless, ... comparative approach ~~is useful~~ *can be used* for a programmatic
54 treatment *until more localized information is available.*"

PHMEIS-4-81, 4.9.1. Marsh Soils, para2, sent4 - "Existing methods have theoretical appeal ... marsh water
55 interface, *however, 'if the broken marsh could be drained for a short time each year for several years, perhaps emergent vegetation could grow in the pond*

areas and build up the elevation of the pond bottoms by the production of a thick root mat. It might be possible to achieve this goal without modification of current Louisiana marsh management techniques'."

PHMEIS-4-83, para3, sent5 - "Management that suppresses ... (Childer and Day 1990a, Cahoon 1991), *however areas that have been breached often allow any imported material to rapidly export the system thereby*
56 *nullifying any benefit that might be gained by introduction.*"

PHMEIS-4-84, para1 - add sentence: "*Nyman at EPA's workshop on structural marsh management (1994) commented that fresh marshes depended more on belowground growth to maintain marsh elevations that they did sediment*
57 *introductions as in the case in more brackish areas.*"

PHMEIS-4-85, para1, sent2 - "For example, a very common ... (Pezeshki et al 1989*), conversely fresh marshes require less mineral input than either brackish or saline*
58 *marshes (Nyman et al 1993c)*."

PHMEIS-4-85, para4 - "To achieve these multiple goals ...
59 for plant colonization." [*What is meant by this?*]

PHMEIS-4-86, para3, sent4 - "In such cases,... to perpetuate the included marsh types, *however this is not always possible especially when considering the potential exists for events to occur that may cause high, short-*
60 *term salinity increases can effectively kill species that are salt-intolerant and erosive actions occur before salt-tolerate species can be established.*"

PHMEIS-4-86, para4 - [*Title and text refer to "exposable" soils. Is this to mean soils that can be exposed during*
61 *drawdown? This needs a definition to clarify meaning.*]

PHMEIS-4-87, para4, sent3 - "Because of this effort ... than
62 those that ~~occurs~~ *occur* when ... managed areas."

PHMEIS-4-87, para5, sent1 - "This significant resource can
63 only be expressed ..." [*What is meant by "expressed"?*]

PHMEIS-4-87, para5, sent3 - "However, in a situation where
64 the targeted ~~ares~~ *areas* is ..."

PHMEIS-4-88, para3, sent2 - "However, a commonly referred to ~~range~~ *ratio* ... is ~~between 50 and 90 percent~~ *70 percent*
65 *land to 30 percent water.*"

PHMEIS-4-90, para1, sent2 - "Management options include
66 excluding ... to reduce turbidity *and encourage growth*

of submerged aquatic vegetation, especially in the case of wigeongrass."

PHMEIS-4-90, para1, sent5 - "However, the source ... may be
67 the managed estuary where ... for the managed area."

PHMEIS-4-91, 4.9.6.4. Composition/Consistency, para4, sent1 - "Soils that consist ... subject to erosion *and tidal*
68 *export* and are not .... vegetation."

PHMEIS-4-96, para3, sent1 - "Expansion of management programs ... and cumulatively, *however Tom Minello at the EPA structural marsh management workshop (1994)*
69 *stated that the fishery resource has been increasing and a collapse is possible without maintenance of the vegetative base."*

PHMEIS-4-96, para5, sent3 - "For the same reason, ... undertake management, *this can even include non-game*
70 *species or communities as envisioned for eco-tourism."*

PHMEIS-4-97, 4.9.8.1.1. Reptiles and Amphibians, para4,
71 sent5 - "Turtles either frequent~~ly~~ the bayous ..."

PHMEIS-4-98, para4, sent1 - "In summary, salt water
72 intrusion, *tend* to be unintended ... actions of man."

PHMEIS-4-98, para6, sent3 - "Managed marshes are used for feeding areas more so than unmanaged areas ~~when water~~
73 ~~levels in unmanaged areas~~."

PHMEIS-4-99, para3, sent2 - "Thus, management ... pipits, meadowlarks, blackbirds, rails and snipe. *Neotropical migrants benefit from wooded levees of managed areas,*
74 *especially as resting and refueling stations during both spring and fall migration (***Olsen** *and Noble, 1976)."*

PHMEIS-4-103, para5, sent1 - "Management for waterfowl typically attempts ... ratios *of about 70:30* ~~that range~~
75 ~~between 50 and 75 %percent~~, ponds with stable ... all the better."

PHMEIS-4-106, para2, sent3 - "As such, slowing water velocities reduces mechanic marsh *detachment and*
76 *exportation*"

PHMEIS-4-107, para2, sent2 - "Enriching sediment budgets ... surplus of sediment, *since this is the natural process*
77 *that has formed the existing deep organic soils in coastal marshes."*

PHMEIS-4-107, para3, sent3 - "The dynamics of sediments ... and retained, *and the amount restricted from export*,
78 has been studied in part but is still largely assumed."

PHMEIS-4-107, para4, sent1 - "Louisiana's coastal marshes
79 exist ... River systems, *and vegetative processes*."

PHMEIS-4-107, para6, sent1 - "Although there is no ... basin scales (Wiseman and Inoue 1993), *however, even fairly short salinity peaks can effectively kill salt*
80 *intolerant vegetation*."

PHMEIS-4-108, para3, sent3 - "Average but local rainfall ... and retention of ~~strom~~ *storm* waters ... salinity
81 conditions."

PHMEIS-4-108, para4, sent6 - "In contrast, salinity ...
82 varied a great deal ~~lees about~~ *less than* the average."

PHMEIS-4-109, para5, sent1 - "Regardless of marsh type, ... zone, can, as the result of chemical reactions ~~can~~
83 affect/immobilize plant ..."

PHMEIS-4-110, para1, sent1 - "nutrients (Pezeshki and DeLaune 1990; Day et al 1989), ~~immobilize plant~~
84 ~~nutrients~~, affect plant ..."

PHMEIS-4-110, para3, sent3 - "In such cases, management, ~~such as hydrologic restoration~~, that strives to
85 maintain ... include marsh types."

PHMEIS-4-110, para4, sent3 - "At a minimum, an initial site assessment ... sponsors a CWPPRA ~~hydrologic restoration~~
86 ~~and marsh management~~ project that are ... design and analysis."

PHMEIS-4-111, para4, sent2 - "Because management ... microbiology of managed and ~~unmanged~~ *unmanaged* coastal
87 Louisiana marshes ... not fully developed."

PHMEIS-4-113, 4.9.17. Nutrients, para4, sent1 - "The ~~Ph~~ *pH*
88 ... water environments."

PHMEIS-4-113, para4, sent3 - "The ~~Ph~~ *pH* of surface water ...
89 and any dilutions."

PHMEIS-4-113, para4, sent3 - "In turn ... temperature,
90 oxygen levels and ~~Ph~~ *pH*."

PHMEIS-4-115, para1, sent8 - "The soluble form is a electrochemically converted ... and when the ~~Ph~~ *pH* is
91 neutral or basic."

PHMEIS-4-115, para2, sent6 - "Shifts in ~~**Ph**~~ *pH* through the
92 production ..."

PHMEIS-4-115, para3, sent3 - "The conversion of sulphate to
93 hydrogen sulfides is not ~~**Ph**~~ *pH* limited ..."

PHMEIS-4-117, para1, sent1 - "~~**unmanged**~~ *unmanaged* marshes."
94

PHMEIS-4-117, para3, sent6 - "Studies of primary productivity in South Carolina coastal, tidal marshes
95 may be insightful, *however, interpretation must be done with care since the hydrology and climatic conditions are quite different from marshes in Louisiana.*"

PHMEIS-4-117, para3, sent8 - "Kelley, McKellar and Zingmark (1986) ... comparison of productivity in managed and
96 ~~**unmanged**~~ *unmanaged* areas."

PHMEIS-4-118, para2, sent1 - "Nonetheless, the biomass ...
97 measure ~~**o**~~ *of* using a pump ..."

PHMEIS-4-118, para3, sent1 -"Trying to draw conclusive ... in managed and ~~**unmanged**~~ *unmanaged* Louisiana marshes
98 from managed and ~~**unmanged**~~ *unmanaged* South Carolina marshes is risky."

PHMEIS-4-120, para4, sent2 -"Taniguchi's (1986) study of managed ~~**an**~~ *and* ~~**unmanged**~~ *unmanaged in* South Carolina is,
99 therefore, indirectly insightful."

PHMEIS-4-124, para3, sent1 -"Utilization of ... between
100 Chaney ~~**Cree**~~ *Creek* and the impoundments."

PHMEIS-4-125, para1, sent1 -"These same at same conclusion would seem to apply to some degree fairly well to
101 managed Louisiana marshes." [*What is this supposed to be?*]

PHMEIS-4-125 add paragraph after para3: "*Other endangered and threatened bird species will not be negatively*
102 *impacted by any hydrologic modifications. (Appendix N)*"

PHMEIS-4-125, para4, sent3 -"Whales, *manatees and sea*
103 *turtles* are similarly characterized."

PHMEIS-4-126, para3, sent2 -"Nonetheless, commercial fishing endeavors ... impact of $1.5 billion, *however, concern must be taken to protect the resource base that*
104 *supports the long-term fishery industry since it may be heading a sharp decline (Minello, EPA Workshop 1994, panel comments)*."

PHMEIS-4-126, para8, sent1 -"More than 3,000,000 user days
105 are expended each year recreationally fishing and

hunting, *in addition non-consumptive uses such as eco-tourism can account for many more user days.*"

PHMEIS-4-128, 4.9.21.5. Displacement of Farms, para3, sent3 - "Therefore, salt water that intrudes ... rice crops
106 quickly *convert* those water unsuitable, ..."

PHMEIS-4-129, 4.9.21.8.2. National Wildlife Refuges, Parks, para4, sent4 - "The remaining refuges ... which may be
107 endangered*,* threatened or rare, ..."

PHMEIS-4-131, para1, sent2 - "Management could have a substantial affect on them, *especially if no action*
108 *results in the loss of the resource base.*"

PHMEIS-4-131, para5, sent1 - "We perceive the issue to be that ... costs of vandalism, *including littering,* and
109 liability claims ... limiting access."

PHMEIS-4-133, para4, sent2 - "The converse may also be true in the longer term." [*I doubt that this is a true*
110 *statement.*]

PHMEIS-4-133, para6, sent2 - "The converse may also be true in the longer term." [*I doubt that this is a true*
111 *statement.*]

PHMEIS-4-134, para4, sent3 - "Some noises associated with activities ~~associated with manage~~ *involving both*
112 *managed and unmanaged* areas, ..."

TABLE 4-1 Comparison of Management Alternatives

PHMEIS-4-138, H.R. column, Hydrology: Velocity MA-2) "only in exceptional cases ..." [*this emulates natural conditions where strong seasonal winds often expose*
113 *shallow water bottoms for extended periods of time*]

PHMEIS-4-146, M.M. column, Water Velocity, S: "some attributes, a valid assumption for others ... related
114 to individual projects;_*amount required unknown*"

PHMEIS-4-148, M.M. column, Reptiles/Amphibians, S:2) "intuitively correct (especially *for amphibians* if
115 marsh shifts from brackish ..."

PHMEIS-4-156, H.R. column, Hazardous, Toxic and Radioactive Wastes, S: "See marsh management; *flow through toxic*
116 *area has potential to spread toxins over larger area*"

PHMEIS-4-157, M.M. and H.R. columns, Bacteria/Fungi/Viruses "~~There~~ *Their* response ..."
117

PHMEIS-4-166, M.M. column, Fish, Shrimp and Crabs/Wildlife,
S: 1) "may prove to be a questionable ... the managed
118 area; *more likely valid for freshwater fisheries;*"

PHMEIS-4-166, M.M. column, Threatened and Endangered
Species, <u>Overall,</u> S: "Management ... but at the expense
of productivity of others, ..." [*This part should not*
119 *be true since M.M. is not done in areas that impact any*
T & E species.]

PHMEIS-4-167, M.M. column, Threatened and Endangered
Species/Marine Mammals, MA: Like not to involve *fish,*
120 *turtles, manatees* ~~the sturgeons~~ or whales. could
involve some birds and ~~turtles~~ *bear;* ..."

PHMEIS-4-167, Significant Resource column, Threatened and
121 Endangered Species/Marine Mammals - add: "*Manatee E*"

PHMEIS-4-168, <u>Fish and Wildlife</u>, M.M. column, S: "Available
documentation ... analyses; North American Waterfowl
122 Management Plan Goals for Gulf coast initiative may
have been *temporarily* met/exceeded"

PHMEIS-4-168, <u>Flood Control</u>, - "Never a stand alone reason
for management; *successful management retains marsh*
123 *reducing potential storm surge;* unsuccessful ..."

PHMEIS-4-168, <u>Flood Control</u>, S: "Available documentation ...
124 analyses; *intuitively correct;* affect on flood ..."

PHMEIS-4-170, <u>Income</u>, S: "Available documentation ...
analyses; however, the effect water control structures
125 have on <u>Displacement of People</u> and <u>Public Access</u>, *are*
questionable, ~~would suggest ... landowner~~"

PHMEIS-5-2, para4, sent3 - "They were also ... desire to do
so, *realizing that most of these are conceptual and*
126 *detailed survey and design work has not yet begun.*"

PHMEIS-5-3, 5.1.1.1. Overview of Pontchartrain Basin CWPPRA
Projects, para2, sent1 - "Five CWPPRA projects are
assumed to be viable candidates for future
127 implementation ..." [*Who made this assumption? Is*
Violet not included (it uses similar measures)?]

PHMEIS-5-3, 5.1.1.2. Profiles of Individual Pontchartrain
Basin CWPPRA Projects, para4, sent2 - "~~Higher water~~
~~levels~~ *Reduced sediment and nutrients from the Pearl*
128 *River* are suspected to have been part of the historic
problem."

PHMEIS-5-3, para4, sent3 - "To mimic ... and the
installation of a fixed-crest weir structure *to divert*
129

water from Slidell into the marsh ~~prevent saltwater intrusion~~."

PHMEIS-5-3, para4, sent4 - "The frequency ... with the ~~unmanged~~ *unmanaged* estuary would be reduced *slightly*
130 *more from the already restricted interchange* to what could occur ... of the marsh."

PHMEIS-5-3, para4, sent4 - "~~The frequency ... marsh~~" [*This entire sentence could be used as a general statement*
131 *and removed from being repeated in each project on all basin sections*]

PHMEIS-5-3, para5, sent3 - "To mimic historic conditions ... rehabilitating ~~debilitated water control structures~~
132 *breaches* ... and salinity intrusions."

PHMEIS-5-3, para5, sent4 - "The frequency ... ~~unmanged~~
133 *unmanaged* estuary or the marsh."

PHMEIS-5-4, para1, sent2 - "Shoreline erosion ... to
134 accelerate *until ponds are breached.*"

PHMEIS-5-4, para1, sent4 - "The frequency ... or the marsh, *however numerous natural routes into the marsh will*
135 *remain unimpeded allowing adequate access.*"

PHMEIS-5-4, para2, sent1 - "Project XPO-51 ... period of record, *and has experienced salinities exceeding 5 ppt*
136 *with no regeneration of cypress on the WMA.*"

PHMEIS-5-4, para2, sent3 - "Shoreline erosion ... are ~~not~~ anticipated to accelerate *since this highly broken*
137 *marsh is on fragile organic soils.*"

PHMEIS-5-4, para2, sent5 - "The frequency ... ~~unmanged~~
138 *unmanaged* estuary ... or the marsh."

PHMEIS-5-6, para7, sent1 - "No CWPPRA projects ... option of choice were *currently* assumed to be viable
139 candidates for future implementation (Plate 3)."

PHMEIS-5-9, para2, sent1 - "Project BA-14 ...marsh loss and ~~some~~ *more recent* shoreline erosion throughout the
140 period of record."

PHMEIS-5-10, para2, sent1 - "Project PBA-35 involves ~~6,450 acres of fresh~~ *7,199 acres of intermediate* marsh ...
141 period of record."

PHMEIS-5-10, para2, sent2 - "Man-made losses ... although
142 ~~limited~~ shoreline erosion losses have also occurred."

PHMEIS-5-10, para2, sent5 - "~~The frequency ... or the marsh~~. *As a result a more diverse and desirable vegetative and improved fish and wildlife habitat will develop in conjunction with the enhancement of the shallow, open*
143 *water areas. The integrity of the adjacent marsh will be preserved through the protection of existing shoreline."*

PHMEIS-5-11, para3, sent1 - "The projects exhibit disconnected, adjacent and capture spatial patterns
144 relative to one another (Plate 4.)" [*What do you really mean by this?*]

PHMEIS-5-12, para2, sent2 - "The type and location of structures to be used would reduce ~~the frequency ... unmanged estuary~~ *the current unlimited exchange however will allow the hydrology to revert back to some semblance as existed prior to degradation of the marsh*
145 *area while ingress and egress of marine organisms will be monitored and the structures operated to maximize communication between the system and surrounding estuary."*

PHMEIS-5-12, para2, sent4 - "In the actively managed areas, more intensive largely seasonal interruptions
146 ~~occur/~~should also be expected, *in order to allow increases in emergent vegetation."*

PHMEIS-5-12, para3, sent1 - "The projects exhibit disconnected, adjacency and internal capture (Plate
147 4.)" [*What do you really mean by this?*]

PHMEIS-5-12, para3, sent4 - "Communication between the upper and lower portion of the basin ... River), *would*
148 *complement the skeletal design of protection that has been proposed by some."*

PHMEIS-5-12, para3, sent5 - "The operational ... CWPPRA projects *if monitoring results indicate the need for*
149 *any fine-tuning."*

PHMEIS-5-12, para4 - add sentence: "*Long-term, larger scale projects have been shown to be more difficult to implement in a timely manner and many of the proposed*
150 *smaller projects will be able to complement the larger scale project if and when they can be constructed."*

PHMEIS-5-13, para2, sent5 - "Project PTE-26 ... is listed in Table **xxx** [*need number*] but not included in the acreage
151 estimates."

PHMEIS-5-14, para2, sent1 - "Project PTE-23/XTE-33 encompasses a *14,587-acre* ~~15,587-acre~~ brackish marsh
152 ~~area)~~ *area* ... of record."

PHMEIS-5-14, para2, sent3 - "Shoreline erosion ... can't be detected *from aerial photography (deepening of water*
153 *areas)*."

PHMEIS-5-14, para2, sent5 - "The frequency ... would retain
154 with ~~unmanged~~ *unmanaged* areas ... or marsh."

PHMEIS-5-15, para1, sent2 - "~~Thus, the frequency ... embankment~~ *This project could be incorporated with the*
155 *parish's proposed hurricane protection and if so will need to be evaluated together*."

PHMEIS-5-16, para2, sent8 - "The frequency ... that opened to the HNC, *insuring that damaging effects with because*
156 *of this exchange are dampened*."

PHMEIS-5-17, para4, sent4 - "Any losses that may have occurred since then have not been measurable through
157 *aerial photography or GIS data*."

PHMEIS-5-18, para2, sent7 - "However, even that ... also be actively managed, *thereby possibly increasing the*
158 *ability and speed of regeneration of emergent vegetation*."

PHMEIS-5-20, para1, sent8 - "Another structure ... ~~relive~~
159 *relieve* an impoundment situation ... project area."

PHMEIS-5-20, para2, sent5 - "The frequency ... or marsh *as naturally occurred prior to the construction of these*
160 *openings*."

PHMEIS-5-21, para3, sent2 - "Therefore, it *would seem* interactions/interdependencies between projects are
161 likely to occur *in some cases, if all projects are implemented*."

PHMEIS-5-22, para1, sent1 - "The type and location of
162 structures ... with the ~~unmanged~~ *unmanaged* estuary."

PHMEIS-5-22, para1, sent3 - "In the actively managed areas, more intensive largely seasonal interruptions should
163 also be expected, *in order to allow increases in emergent vegetation*."

PHMEIS-5-22, para2, sent5 - "The operational ... CWPPRA projects *if monitoring results indicate the need for*
164 *any fine-tuning*."

PHMEIS-5-22, para3 - add sentence: "*Long-term, larger scale projects have been shown to be more difficult to*
165 *implement in a timely manner and many of the proposed*

smaller projects will be able to complement the larger scale project."

PHMEIS-5-22, para4, sent2 -"The effects of altered ... City, and *unmanaged* portions of the Paul J. Rainey Wildlife
166 Refuge."

PHMEIS-5-23, para4, sent2 - "~~Very little~~ Internal marsh loss
167 was *also* recorded."

PHMEIS-5-22, para4, sent3 - "Wind-driven waves ~~from prevailing winds~~ is the suspected reason for the
168 erosion."

PHMEIS-5-22, para4, sent4 - "~~Any internal ... not~~
169 ~~deductable~~."

PHMEIS-5-23, para5, sent6 - "To mimic historic ... low level rock weirs with boat or barge bays at major
170 waterway ....Cote Blanche Bay~~s and several one-way flap-gated culverts to control introductions of fresher water and sediments~~."

PHMEIS-5-23, para5, sent8 - "~~The frequency ... or marsh~~."
171

PHMEIS-5-23, para5, sent9 - "~~Freshwater and ... in canal~~
172 ~~embankments)~~."

PHMEIS-5-24, para2, sent3 - "Interior marsh erosion ... *are*
173 *difficult to* ~~can't be~~ detect~~ed~~."

PHMEIS-5-24, para2, sent5 - "~~The frequency ... overtopped~~
174 ~~the structures.~~"

PHMEIS-5-24, para2, sent6 - "~~Nonetheless~~, The targeted ..."
175

PHMEIS-5-24, para3, sent6 - "~~The frequency ... overtopped~~
176 ~~the structures.~~"

PHMEIS-5-24, para4, sent1 - "Hydrologic restoration *is*
177 *currently* ~~would be~~ the only ..."

PHMEIS-5-26, para2, sent1 - "The type ... ~~every~~ *each* managed area~~s~~ would retain with the *unmanaged* ~~unmanged~~
178 estuary."

PHMEIS-5-24, para2, sent3 - "In the actively ... also be
179 expected *in order to achieve revegetation.*"

PHMEIS-5-24, para5, sent2 - "Subsequent evaluations
180 performed during ... approaches for ~~all~~ *some* projects."

PHMEIS-5-24, para5, sent2 - "~~The frequency ... overtopped~~
181 ~~the structures, marsh or perimeter embankments~~ *These*

modifications would increase the capability to fine-tune management options according to monitoring results."

PHMEIS-5-28, para4, sent5 - "~~Therefore, the communication ... and/or any perimeter embankments~~."
182

PHMEIS-5-30, para4, sent1 - "The type and location ... with
183 the *unmanaged* ~~unmanged~~ estuary."

PHMEIS-5-30, para7, sent3 - "Water with stressful or toxic
184 levels of ~~saline~~ *salinity* that were ..."

PHMEIS-5-31, para5 - "Project PCS-25 encompasses a ~~650-acre fresh/intermediate~~ *1125-acre intermediate/brackish* marsh area *that* has exhibited relatively high marsh loss, especially during the ~~1956-1963~~ *1958-1974* time frame. The *natural* effects *of* ~~from~~ shoreline ~~breaches and canals~~ *erosion and subsidence in combination with man-made hydrologic alterations* are *major contributors to* ~~suspected of being part of~~ the historic land loss
185 problem. ~~Losses~~ *Land loss rates* in the project area are ~~not expected to accelerate or remain high~~ *currently on a downward trend due to the absence of severe storm events in the past several years and the freshwater influence from the Intracoastal Canal via artificial openings*. To mimic historic conditions this actively operated hydrologic restoration project ~~would~~ involves the installation of new flap-gated culverts, ~~replacement of existing flap-gated culverts and the placement of a solid~~ *earthen* plugs ~~in a shoreline~~ *freshwater introduction. Vegetative plantings are proposed along Calcasieu Lake shoreline to assist in preserving the critical hydrological barrier the shoreline provides.* ~~The frequency ... overtopped the structures or marsh.~~ *The project's objective is to re-establish a more desirable hydrologic regime within the area with passive management of the operable structures to the extent that benefits derived are not compromised by high lake salinities and excessive tidal exchanges."*

PHMEIS-5-32, para3, sent4 - "~~The frequency ... overtopped~~
186 ~~the structures, marsh or perimeter embankments~~."

PHMEIS-5-33, para2, sent1 - "Project XCS-48 (SO-5)
187 encompasses a 12,0~~0~~07-acre ..."

PHMEIS-5-33, para2, sent6 - "~~The frequency ... overtopped~~
188 ~~the structures, or nearby beach rim~~."

PHMEIS-5-33, para3, sent2 - "~~The effects ... loss problem~~.
Increased tidal dynamics and salinity associated with
189 *subsequent deepenings of the Calcasieu Ship Channel are two of the primary forces contributing to marsh loss."*

PHMEIS-5-33, para3, sent3 - "Losses in the project area may remain high or *could* even accelerate *without the*
190 *project*."

PHMEIS-5-33, para3, sent4 - "~~This project would not ... for~~
191 ~~the first time~~."

PHMEIS-5-33, para3, sent4 - "This actively ... earthen
192 plugs, ~~ant~~ *and* the"

PHMEIS-5-34, para1, sent1 - "restoration of ~~nearly a mile of~~
193 the existing *boundary* embankment."

PHMEIS-5-34, para1, sent1 - "~~The frequency ... or the marsh~~. *The management of the system will allow the hydrology to revert back to some semblance as existed prior to*
194 *degradation of the marsh area. The salinity spikes associated with rapid tidal exchange will be buffered and retarded by water management within the system. Ingress and egress of marine organisms will be monitored and the structures operated to maximize communication between the system and surrounding estuary*."

PHMEIS-5-34, para2, sent9 - "The canal that would be ... the
195 ship channel *and the direct avenue for salt water*."

PHMEIS-5-34, para3, sent1 - "Project XCS-47/48i,j,k,p would
196 affect an estimated ~~41,857~~ *42,247* acres ..."."

PHMEIS-5-35, para2, sent3 - "To mimic the historic ... water control structure ~~(design unspecified)~~ ..." [*These are*
197 *conceptual plans so the structures would not be designed at this point*]

PHMEIS-5-35, para3, sent11 - "Project SA-01 is classified as a nutrient trapping project ~~but~~ *and* water levels ..."
198 [*Both Nyman and Touchet have shown that, especially in the chenier plain, the soils formation is due primarily to organic material and vegetation will effectively trap this organic detritus*]

PHMEIS-5-36, para1, sent3 - "~~The frequency ... overtopped~~
199 ~~the structures, marsh or perimeter embankments~~."

PHMEIS-5-36, para2, sent3 - "Increased tidal dynamics and salinity associated with subsequent deepenings of the Calcasieu Ship Channel ~~are suspected of being part of~~
200 ~~the historic loss problem~~ *two of the primary forces contributing to marsh loss*."

PHMEIS-5-36, para2, sent4 - "This actively ... variable
201 crested *slotted* weir *inlet sections* fitted with

flapgated culverts, ~~to create the opportunity to conduct water level drawdowns~~ *a weir with a boat bay, and a freshwater/nutrient introduction structure.*"

202 PHMEIS-5-36, para2, sent5 - "~~The frequency ... or the marsh~~. *This system of structures will allow management of the area by somewhat restoring the hydrology of this unit and retarding the influx of high saline tidal surges. Operation of the structures will be in a manner to maximize migration between the system and surrounding area as monitoring and salinities dictate.*"

203 PHMEIS-5-36, para3, sent6 - "~~The frequency ... overtopped the marsh~~."

204 PHMEIS-5-37, para2, sent12 - "~~The frequency ... overtopped the structures and/or the perimeter embankments~~."

205 PHMEIS-5-38, para2, sent3 - "~~Although~~ Classified *under* ~~as a~~ CWPPRA *as* sediment trapping, *the* implementation of this project ..." [*Both Nyman and Touchet have shown that, especially in the chenier plain, the soils formation is due primarily to organic material and vegetation will effectively trap this organic detritus*]

206 PHMEIS-5-38, para2, sent4 - "~~The frequency ... overtopped the structures, marsh or perimeter embankments~~."

207 PHMEIS-5-38, para4, sent1 - "Project *XCS-48* (NO-3) ..."

208 PHMEIS-5-39, para1, sent1 - "targeted interior marshes ... estuary would remain *at current conditions* ~~whatever passed into the area ... overtopped the structures, marsh or perimeter embankments~~."

209 PHMEIS-5-39, para3, sent1 - "Project XCS-*48 (NO*-14,15 and 17*)* are ..."

210 PHMEIS-5-39, para4, sent1 - "Project *XCS-48* (NO-14) ..."

211 PHMEIS-5-39, para4, sent3 - "~~The frequency ... overtopped the structures, marsh or perimeter embankments~~."

212 PHMEIS-5-39, para5, sent1 - "Project *XCS-48* (NO-15 and NO-17) ..."

213 PHMEIS-5-39, para5, sent1 - "To mimic historic conditions in the project area ... and a structure ~~of unspecified~~ (*to be* designed) would be ..."

214 PHMEIS-5-40, para1, sent2 - "~~The frequency ... overtopped the structures, marsh or perimeter embankments~~."

PHMEIS-5-40, para1, sent6 - "~~The frequency ... overtopped~~
215 ~~the structures, marsh or perimeter embankments~~."

PHMEIS-5-40, para2, sent1 - "Project *XCS-48* (NO-13) ..."
216

PHMEIS-5-40, para2, sent6 - "~~The frequency ... overtopped~~
217 ~~the structures, marsh or perimeter embankments~~."

PHMEIS-5-41, para1, sent1 - "Project *XCS-48* (NO-14a) ..."
218

PHMEIS-5-41, para1, sent6 - "~~The frequency ... overtopped~~
219 ~~the structures, marsh or perimeter embankments~~."

PHMEIS-5-41, para3, sent1 - "Project area XCS-48 (NO-18) encompasses a 4,422-acre parcel of fresh, intermediate
220 and brackish marsh, *prairie*, and open water."

PHMEIS-5-41, para3, sent2 - "This historic intermediate marsh has exhibited ~~relatively little~~ loss during the
221 period of record."

PHMEIS-5-41, para3, sent3 - "~~Rather~~ It has exhibited ~~a~~ marsh
222 type changes ..."

PHMEIS-5-41, para3, sent1 - "Project XCS-*48* (*NO*-19,20 and
223 21*)* comprise the ..."

PHMEIS-5-41, para4, sent1 - "Project XCS-*48* (*NO*-19) encompasses a 9,667-acre parcel of fresh, intermediate
224 and brackish marsh vegetation types, *prairie,* and open water."

PHMEIS-5-42, para1, sent4 - "~~The frequency ... overtopped~~
225 ~~the natural and man-made embankments~~."

PHMEIS-5-42, para2, sent6 - "~~The frequency ... overtopped~~
226 ~~the structures and the marsh~~."

PHMEIS-5-42, para3, sent5 - "~~The frequency ... overtopped~~
227 ~~the marsh~~."

PHMEIS-5-43, para2, sent5 - "~~The frequency ... overtopped~~
228 ~~the marsh~~."

PHMEIS-5-43, para3, sent5 - "~~The frequency ... overtopped~~
229 ~~the marsh~~."

PHMEIS-5-44, para1, sent1 - "Project *XCS-48* (SA-3) ..."
230

PHMEIS-5-44, para1, sent12 - "~~The frequency ... overtopped~~
231 ~~the perimeter structures~~."

PHMEIS-5-44, para2, sent1 - "Project *XCS-48* (SA-4) ..."
232

PHMEIS-5-44, para2, sent4 - "~~Wind-induced erosion in shallow~~
233 ~~water... in the future~~."

PHMEIS-5-44, para3, sent1 - "Project *XCS-48* (SA-6) ..."
234

PHMEIS-5-45, para2, sent1 - "Project areas SA-4 and SA-6
235 historically could ..."

PHMEIS-5-45, para2, sent7 - "~~Thus, the frequency ...~~
236 ~~overtopped the marsh~~."

PHMEIS-5-45, para3, sent2 - "This parcel ... time frame, *and includes a small area of prairie-like marsh in the*
237 *lower west side of the unit.*"

PHMEIS-5-45, para3, sent3 - "~~More recently, an increase in the amount ... sites, was reported~~." [*This sentence is*
238 *repeated later in this same paragraph*]

PHMEIS-5-46, para1, sent4 - "~~If not, the frequency ...~~
239 ~~overtopped the structures and marsh~~."

PHMEIS-5-46, para2, sent3 - "~~Even more recently, an increase in the amount ... sites, was reported~~." [*This sentence*
240 *is repeated later in this same paragraph*]

PHMEIS-5-46, para2, sent8 - "~~If not, he frequency ...~~
241 ~~overtopped the structures, embankment and marsh~~."

PHMEIS-5-47, para2, sent2 - "This parcel was historically mapped as intermediate and ~~excessively drained saline~~
242 *brackish* marsh ~~The parcel was characterized as stable marsh~~ with little loss."

PHMEIS-5-47, para2, sent5 - "~~The frequency ... overtopped~~
243 ~~the structures and marsh~~."

PHMEIS-5-47, para3, sent7 - "~~The frequency ... overtopped~~
244 ~~the structures and marsh~~."

PHMEIS-5-47, para4, sent1 - "Project area XCS-48 (SO-2) is a
245 ~~23,763-acre~~ *30,585*-acre parcel."

PHMEIS-5-47, para4, sent3 - "~~The wetland areas were historically mapped as excessively drained saline~~
246 ~~marsh~~."

PHMEIS-5-47, para4, sent7 - "~~The frequency ... overtopped~~
247 ~~the structures and marsh~~."

PHMEIS-5-48, para2, sent1 - "Project area XCS-48 (SO-4)
248 encompasses 6,800-acres ~~parcel~~ of ~~the~~ intermediate marsh ~~types~~ with relatively little open water."

PHMEIS-5-48, para2, sent2 - "This parcel was historically mapped as either brackish *or intermediate* marsh
249 *depending upon environmental conditions*."

PHMEIS-5-48, para2, sent6 - "~~Thus, the frequency ... overtopped the structures or the dredged material~~
250 ~~embankment~~."

PHMEIS-5-49, para4, sent1 - "The remainder of the marshes ... are not *totally* immune from undergoing *some* marsh
251 loss *even with limited protection*."

PHMEIS-5-49, para5, sent2 - "However, losses ... of the Calcasieu Ship Channel from **???** feet deep to **???** feet
252 deep (19**??**)." [*Need to fill in these blanks*]

PHMEIS-5-49, para6 - add: "5) *protect and/or restore the areas within the basin both historically and currently*
253 *undergoing erosion*."

PHMEIS-5-51, para3, sent1 - "The type and location of structures ... ~~unmanged~~ *unmanaged* estuary, *to the*
254 *extent necessary to achieve restoration and protection of the area*."

PHMEIS-5-51, para3, sent4 - "CWPPRA project designs rely heavily upon rock weirs as control structures *since the*
255 *typical soils in this basin can readily support these type structures*."

PHMEIS-5-51, para4, sent7 - "Therefore, the consequences ... expected consequences from management in Basin 4
256 (Barataria) and Basin 5 (Terrebonne) *both of consist of more recent, deep organic soils of the deltaic plain*."

PHMEIS-5-52, para2, sent1 - "Hydrologic restoration is *often*
257 the management ..."

PHMEIS-5-53, para1, sent2 - "The intent of every marsh management project and most of the hydrologic restoration projects appears to be to make the targeted
258 area physically and hydrologically unique from the rest of the *eroding* ~~unmanged~~ *unmanaged* system *in order to restore it to the condition prior to alteration by human activities*."

PHMEIS-5-53, para6, sent2 - "Hydrologic restoration ... for
259 future projects, *where possible*."

PHMEIS-5-54, para4, sent2 - "A possible consequence would be to further disrupt the hydrology of the remaining
260 unmanaged marsh, *however since the objective for the current hydrologically-altered systems typically is an*

attempt to mimic previous natural conditions a net benefit is expected."

PHMEIS-5-55, para3, sent3 - "Areas likely to continue to exhibit ... do occur, *and because of the recent fresher conditions current loss rates may have temporarily*
261 *declined."*

PHMEIS-5-55, para4, sent3 - "Specifically, ... ~~unmanged~~ *unmanaged* marsh under management."
262

TABLE 5-1 Cumulative Effects

PHMEIS-5-57, Coastwide column, Emergent Vegetation on Uneroded Native Soil - "However, adequately or even ...
263 represented; *on-site observations over time have shown site-specific effectiveness*"

PHMEIS-5-58, Coastwide column - "5) Collectively ... reversing erosion in academic publications, *however land managers have had excellent responses when able to*
264 *manipulate structures according to changeable conditions*"

PHMEIS-5-59, Coastwide column, Emergent Vegetation on Exposable Eroded Soil - "However, adequately ...
265 represented; *on-site observations over time have shown site-specific effectiveness*"

PHMEIS-5-60, Coastwide column - "4) Collectively ... reversing erosion in academic publications, *however land managers have had excellent responses when able to*
266 *manipulate structures according to changeable conditions*"

PHMEIS-5-61, Coastwide column, Emergent Vegetation on Exposable Eroded Soil - "However, adequately ...
267 represented; *on-site observations over time have shown site-specific effectiveness*"

PHMEIS-5-62, Coastwide column - "4) Collectively ... reversing erosion in academic publications, *however land managers have had excellent responses when able to*
268 *manipulate structures according to changeable conditions*"

PHMEIS-5-62, Coastwide column - "6) Research ... responses to management; *even this though is subject to differing*
269 *interpretation*

PHMEIS-5-63, Coastwide column, Submerged/Floating Aquatic Vegetation - "However, adequately ... represented; *on-*
270 *site observations over time have shown site-specific effectiveness*"

PHMEIS-5-64, Coastwide column - "3) Past and future ...
inducing ~~emergent~~ *submerged/floating aquatic* vegetation
271 to grow ~~on exposable, eroded marsh soils~~ contributes to
forestalling ~~marsh~~ loss~~es~~ *of beneficial habitat*"

PHMEIS-5-64, Coastwide column - "4) Collectively ...
reversing erosion in academic publications, *however
land managers have had excellent responses when able to*
272 *manipulate structures according to changeable
conditions*"

PHMEIS-5-64, Coastwide column - "6) Research ... responses
to management; *even this though is subject to differing*
273 *interpretation*

PHMEIS-5-65, Chenier Basin column, Marsh Pond Soils - "Every
permitted project ... and/or other purposes *(such as*
274 *reclaiming deeper, less productive ponds)*"

PHMEIS-5-65, Delta Basin column - "Areas... and/or other
purposes *(such as reclaiming deeper, less productive*
275 *ponds and/or retaining lighter organic matter)*"

PHMEIS-5-65, Chenier Basin column - "Every one of the
proposed projects ... and/or other purposes *(such as*
276 *reclaiming deeper, less productive ponds)*"

PHMEIS-5-65, Coastwide column - "Historic 2) Generally poor
literature accounts *since managers are responsible for
saving resource rather than doing research* and ... in
277 similar situations; *on-site observations of benefits
have been extensive*"

PHMEIS-5-66, Delta Basin column, Fish, Shrimp and Crabs
- "2) Most management efforts ... between marshes and
marsh types *but the studies on extent and effect have*
278 *been either unknown or contradictory*; more successful
management ..."

PHMEIS-5-66, Chenier Basin column - "2) Most management
efforts ... between marshes and marsh types *but the*
279 *studies on extent and effect have been either unknown
or contradictory*; more successful management ..."

PHMEIS-5-66, Delta Basin column - "Project landscape
patterns ... reduced/rerouted from *the current* several
to as ... more than one structure; *the historical
access in many cases may actually be closer to*
280 *resembling the managed access than the current altered
direct routes*"

PHMEIS-5-66, Chenier Basin column - "Project landscape
281 patterns ... reduced/rerouted from *the current* several

to as ... more than one structure; *the historical access in many cases may actually be closer to resembling the managed access than the current altered direct routes*"

PHMEIS-5-66, Coastwide column - "1) Generally poor monitoring compliance, *and large expense of time and* 282 *money required to properly monitor* -"

PHMEIS-5-68, Delta Basin column, Wildlife - "2)Improved conditions ... most of the ~~100~~ *150* bird~~s~~ species and 283 ~~two or three~~ *most* of the dozen or so mammalian species that ..."

PHMEIS-5-68, Chenier Basin column - "2) Improved conditions ... most of the ~~100~~ *150* bird~~s~~ species and ~~two or three~~ 284 *most* of the dozen or so mammalian species ..."

PHMEIS-5-68, Coastwide column - "3) In all basins, a- the wildlife ... marsh types ~~drops dramatically~~ [*this is incorrect, many species do benefit in all marsh types* 285 *with management from shorebirds to neotropic migrants*], and ..."

PHMEIS-5-70, Coastwide column - "9) Management efforts ... unmanaged marsh undergo ~~natural succession~~ *continued* 286 *erosion*"

PHMEIS-5-70, Coastwide column - add: "*10) An additional source of economic benefit in managed areas that is likely to increase is non-consumptive uses such as* 287 *guided field trips for bird watching, photography, etc.*"

PHMEIS-5-72, Delta Basin column, Surface Geomorphology - "The permitting effort ... semi-disconnected parcels, *a* 288 *large part as a result of the managing effort required if more than one manager (owner) is involved*"

PHMEIS-5-72, Coastwide column - "Many areas influenced by those features ... in the Chenier marshes; *conversely many areas influenced by these features are the only* 289 *remaining uneroded fresh marshes in both Chenier and Deltaic marshes*"

PHMEIS-5-72, Coastwide column - "The historic condition and a continuing ... continue that trend *as a result of* 290 *single-decision maker impact when one landowner is involved*"

PHMEIS-5-73, Hydrology, Delta Basins column - "The hydrology of 235,315 acres of Basin 4 is presumed to *already* be 291 affected *by human alterations and similar areas in other basins are also affected*, ..."

PHMEIS-5-73, Delta Basins column - "1) Every one of the ... and/or other purpose *such as mimicking the natural*
292 *conditions before alteration*"

PHMEIS-5-73, Chenier Basins column - "The hydrology *of areas already affected by human alteration is greater than*
293 the 92,480 acres ..."

PHMEIS-5-73, Chenier Basins column - "1) Every one of ... and/or other purpose *such as mimicking the natural*
294 *conditions before alteration*"

PHMEIS-5-73, Chenier Basins column - "2) Because of ...
295 modified, with~~out~~ little or no ... in the basin"

PHMEIS-5-74, Delta Basins column - "The commitment to ... in that Basin *in order to modify damages caused by*
296 *previous alteration of hydrology*"

PHMEIS-5-74, Chenier Basins column - "3) Because of proposed ... intentionally *modified in order to address*
297 *hydrologic changes that have occurred;* ..."

PHMEIS-5-74, Chenier Basins column - "3) More of the marshes in this ... respond to the ~~natural~~ *current* rhythms of
298 the unmanaged estuary *in this altered state;* ..."

PHMEIS-5-75, Delta Basins column - *see PHMEIS-5-73*

PHMEIS-5-75, Chenier Basins column - *see PHMEIS-5-73*

PHMEIS-5-76, Delta Basins column - *see PHMEIS-5-74*

PHMEIS-5-76, Chenier Basins column - *see PHMEIS-5-74*

PHMEIS-5-77, Delta Basins column - *see PHMEIS-5-73*

PHMEIS-5-77, Chenier Basins column - *see PHMEIS-5-73*

PHMEIS-5-78, Delta Basins column - *see PHMEIS-5-74*

PHMEIS-5-78, Chenier Basins column - *see PHMEIS-5-74*

PHMEIS-5-79, Hazardous, Toxic & Radioactive Wastes, Delta Basins column - "Procedures exist to ... on a case-by-
299 case basis; *there is a push to utilize some questionable material as fill but the potential problems have not yet been evaluated*"

PHMEIS-5-79, Chenier Basins column - *see Delta Basins*
300

PHMEIS-5-79, Coastwide column - "This significant resource
301 is not *yet* expected to be knowingly subjected to

management, *however there exists the possibility that questionable material could be placed in marsh areas*"

PHMEIS-5-83 - [*This page is blank - should anything be here?*
302 *If not delete!*]

PHMEIS-5-87, Coastwide column - "10) Management efforts ... unmanaged marsh undergo ~~natural succession~~ *continued*
303 *erosion* ..."

PHMEIS-5-87, Coastwide column - "NOTE: The alligator and
304 *peregrine* falcon ..."

PHMEIS-5-90, Coastwide column - "6) Management efforts ... unmanaged marsh undergo ~~natural succession~~ *continued*
305 *erosion* ..."

PHMEIS-5-92, para2, sent3 - "Those numbers*, like the amount of erosion occurring in Louisiana,* are stunning, *and*
306 *are indicative of the interest in restoring marshes*."

PHMEIS-5-92, para4, sent2 - "Most of the information ... life requisite resources*, since this was the charge of*
307 *marsh managers*."

PHMEIS-5-92, para5, sent2 - "The results ... as practiced in Louisiana; *however they are quite different in*
308 *climate, soils, elevations and tidal actions) can be somewhat* ~~are~~ insightful."

PHMEIS-5-92, para5, sent3 - "Productivity of managed and
309 ~~unmanged~~ *unmanaged* marshes ..."

PHMEIS-5-93, para3, sent1 - "Regardless, ... trade-offs, *and with the losses that are occurring in Louisiana the*
310 *management option of doing nothing is neither politically or economically practical.*"

PHMEIS-5-94, para2, sent5 - "The question is ... they help steward, *and what laws protect liability if public*
311 *access is required.*"

PHMEIS-6-3, bullet1 - "June 1995 - 50% Review version sent
312 to cooperating ~~ageinces~~ *agencies* for review and comment."

--- {Pages PHMEIS-7-1 through PHMEIS-7-5 are labeled as
313 DEIS-7-1 through DEIS-7-5}

8.0 *LITERATURE CITED and OTHER REFERENCES*

--- {Pages PHMEIS-8-1 through PHMEIS-8-41 are labeled as
314 PHMEID-8-1 through PHMEID-8-41}

PHMEIS-8-5:
Chabreck, Robert H. 1976. Management of wetlands for
wildlife habitat improvement. Pages 226-233, in M.
Wiley, ed. Estuarine Processes, Volume I - Uses,
315 Stresses and Adaptation to the Estuary. Academic Press.
New York [NRCS]

PHMEIS-8-6:
Chabreck, R.H., T. Joanen and S.L. Paulus. 1989. Southern
coastal marshes and lakes. Pages 249-277 in L.M. Smith,
R.L. Pederson, and R.M. Kaminski, eds. Habitat
316 management for migrating and wintering waterfowl in
North America. Texas Tech Univ. Press, Lubbock, TX
[NRCS, EPA]*

PHMEIS-8-9:
Davidson, Richard B. and Robert H. Chabreck. 1984. Fish,
wildlife and recreational values of brackish marsh
impoundments. Pages 89-114 in N.V. Brodtmann, Jr., ed.
317 Water Quality & Wetlands Management Conf., New Orleans,
LA [NRCS]

PHMEIS-8-12:
Dundee, H. A. and D. A. Rossman 1989. The Amphibians and
318 Reptiles of Louisiana. LSU Press, Baton Rouge. 300pp.

PHMEIS-8-14:
Gan, C. E. and E. J. Luzar. 1992. Conjoint analysis of
wetland-based recreation activities. Pages 330-333 in
M. C. Landin, ed. Wetlands: Proceedings of the 13th
319 Annual Conference of the Society of Wetland Scientists,
Utica, MS, USA. 990pp. [NRCS]*

PHMEIS-8-16:
Hatton, R. S., R. D. DeLaune and W. H. Patrick, Jr. 1983.
Sedimentation, accretion, and subsidence in marshes of
320 Barataria Basin, Louisiana. Limn. & Oceanog. 28(3):494-
502. [NRCS, COE]

Helmers, D. L. 1992. Shorebird Management Manual. Western
Hemisphere Shorebird Reserve Network. Wetlands for the
321 Americas Publication No.3. Manomet, MA. 58pp. [NRCS]

PHMEIS-8-32:
Ross, G. N. 1995. Butterfly Wrangling in Louisiana. Natural
322 History, May 1995, p.36-43.

PHMEIS-8-37:
Touchet, B. A. 1994. Genesis of the Louisiana Coastal
323 Marshes. 11pp.

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324 Pontchartrain Basin (Basin No.1) - *basin boundary not shown*

APPENDIXES:

D - NRCS's Project Process Narrative - [*missing - was*
provided July 19, 1995. If you need another copy
325 *contact me.*]

H - Basin-by-basin Landscape Characterizations: *Figure*
326 *numbers and title need to be typed not handwritten*

H-2, Figure 1 - [*why are the rectangles (15' quads?)*
327 *included, since they detract from the basin*
boundaries?] [*cite map (FROM Chabreck, 1972?*]

H-5, papa3, 3. Direct man-made loss - [*This is a major*
consequence in land loss and needs dramatic expansion
328 *rather than just a short paragraph. Explanation of how*
vegetation holds the soil in place and when killed
allows the soil to be removed with each tidal flow is
an important concept that needs to be included. This
was addressed in 50% draft on 7/19/95.]

H-5 add a summary paragraph - "*Much of the interior land*
loss has occurred on fragile organic soils, especially
in areas that were historically fresh/intermediate.
Although aerial photography will often show only minor
329 *amounts of erosion rates on-site investigations can*
provide information that these areas are becoming
deeper, thereby reducing their ability to be
efficiently restored and/or support submerged aquatic
vegetation." [*This was also addressed in 50% draft on*
7/19/95.]

I Avifauna:

I-4, para3, sent2 - "Microhabitat requirements ... open
330 shallows (*up to* 15 cm)."

I-4, para4, sent5 - "Purple gallinules ... salinity (*less*
than 5 ppt. salt content) marshes."
331

J-1, 1.2., para2, sent1 - "The primary functions of ...
salinity levels, sediment ~~loads~~ *export*, flow velocity,
332 and ... tidal flows."

J-14, 2.5 Terrebonne Basin, para2, sent13 - "Agricultural
333 production ... basin ~~is also important~~, including ..."

J-16, 3.1.1.1. Existing Conditions - add final sentence to
first paragraph: "*Fisheries data is difficult to*
334 *determine the point of catch since any information is*
only obtainable at the landing. Much of the data is
determined according to parish, however there is no
guarantee that the species, especially marine species,
was even caught within Louisiana waters."

J-17, para2, sent1 - "Despite the intense ... restaurants,
335 boat~~s~~ building and repair yards, ... marinas."

J-17, para2 - add sentence: "*Concern must be taken to protect the resource base that supports the long-term fishery industry. At the August 1994 EPA Workshop on*
336 *Marsh Management held in New Orleans, fisheries was identified as being on an upward curve, yet heading for a sharp decline (Minello, panel comments)*."

J-17, para3, sent2 - "After years of closed seasons,
337 alligator hunting ..."

J-17, para4, sent6 - "The decline ... has become an~~d~~
338 increasing concern ... certain furbearers."

J-18, 3.1.2.1. Existing Conditions., para3, sent2 - "Freshwater fish species ... crappie, blue catfish,
339 channel catfish, ... sunfish."

J-18, para3, sent7 - "Big and small game ... and gray and
340 ~~red~~ *fox* squirrels, ... much lesser degree."

J-20, 3.1.2.2. No Action, para3, sent3 - "~~A significant marsh management consideration ... conditions change~~." [*This is a property rights issue and should not be*
341 *included here. If anything the decrease in resource through erosion will only increase pressures and therefore conflicts because of limited resources.*]

J-21, para1, sent2 - "*In some cases*, the system of levees, in addition to subsidence, ...erosive tidal action.
342 *However, other levees have been constructed to replace or repair breaches in the higher natural bayou banks.*"

J-21, para2, sent4 - "The degree to which coastal wetlands can ameliorate ... should be addressed in *all* ~~future~~
343 ~~marsh management~~ permit applications, not just marsh management.

J-22, 3.3.1. Existing Conditions, para1, sent3 - "Another concern ... mineral rights, *the recent Constitution*
344 *Amendment passage should alleviate that as a factor*."

J-24, 3.4.2. No action, para2 - [*How is this different from*
345 *any other CWPPRA project where loss rates are reduced?*]

J-26, para1, sent2 - "The reduction will be more ... but at a lower rate, *except in actively managed areas where*
346 *increases in emergent marsh are predicted*."

J-26, 3.7.3. Permit Requirement., para2 - add sentence: "*However, some of the property rights issues that have*
347 *been listed in this report as controversial in coastal*

marshes are currently unresolved legal issues and not factors in the permitting process."

J-27, 3.9.3. Permit Requirement., para3, sent1 - "Future permit applications for ~~marsh management~~ *all* projects,
348 *including marsh management,* should be ... their proposals."

J-27, 3.10.1. Existing Conditions, para4, sent2 - "As discussed in ... somewhat higher than per capita~~l~~
349 personal income ...was $14,530."

J-29, 3.11.2 No Action, para5, sent.3 - "It states that ... enormously expensive for the state, *however some of the proposals in this 'White Paper' also include*
350 *relocations and sacrificing some coastal areas which may be theoretically feasible but have social and financial considerations that make the approach unlikely at best." [With elections just held it may be best to avoid mention of the "White Paper" since that may no longer exist after January.]*

351 K Prime and Unique Farmlands: Table K-1 - [*missing*]

M Management Structures:

M-2, para4, sent2 - "Reduction of these effects, *where*
352 *perceived to have negative impacts, could possibly* ~~can be~~ the subject of mitigation."

M-2, para5 - add sent2: "*More typically these are used to return the area to a more 'natural' configuration where*
353 *man's impact has resulted in breaching a ridge or bayou bank.* Reduction of ~~these~~ *any negative* effects can be the subject of mitigation.""

M-4, (M.2. Rock Weirs) paras1&2 - "... block *trespass into* ~~access by the public to~~ managed areas." [*This is more*
354 *of property rights issue and should be mentioned early in report that it is such, therefore it has no bearing on management issues and will not be further addressed.*]

M-4, para3, sent2 - "*Some* marsh soils don't readily support
355 their ..."

M-4, para3, sent4 - "As such, NOD concludes ... limited studies (*as is the case with most management components*
356 *other than wooden fixed-crest weirs*) and fewer field applications."

M-5, para3, sent1 - "The desired management effects are to: ... tidal action)*; 3) return the impacted are to its*
357 *historically fresher condition;* and, *4)* ~~3)~~ retain enough water ..."

M-5, para5, sent1 - "Sometimes unintended ... 1) immediately reduced access ...management objectives, and/or 2) ..."
358 [*This again implies property rights and laws of trespass are to be ignored and areas treated on in the interest of those wishing to have access on all lands*

regardless of ownership. This issue should be eliminated from this report except in an introductory statement explaining that property rights issues may have conflict with some special interest groups.]

M-7 (M.4. Vertical-slotted weir) para2, sent1 - "Often unintended ... 1) a fairly quickly and measurable suppression of fisheries *is believed however nothing is actually be proven as to what size requirements are necessary for post-larval and juvenile forms to access*
359 *areas (supposedly solid plugs have somehow allowed marine organisms to access them), these structures definitely allow more access that fixed-crest weirs, but conversely the objectives may not be as readily reached;* 2) ..." *[this concern was also addressed in the 50% review 7/19/95*]

M-7, para5, sent1 - "The effectiveness of ~~fixed-crest~~
360 *vertical-slotted* weirs..."

M-7, para5 - add final sentence: "*The effectiveness of a vertical-slotted weir has not been adequately compared to a similar control area without slots for a*
361 *sufficient time period to determine that the is not adversely effected by the inclusion of slots.*"

M-8, para.2, sent1 - "The contribution *vertical-slotted*
362 fixed-crest weirs make ..."

M-9, (M.5. Variable-crest weir) para5, sent3 - "A few fishermen may apply that knowledge, in the extreme by fishing with nets ... management settings, *these are*
363 *often the same individuals who ignore trespass laws and demand access to posted property.*" [*Actually, this entire paragraph can be removed since it relies heavily on speculations that are either very minor or are extremely rare in occurrence.*]

M-10 - add paragraph between paras4&5: "*The availability to fine-tune management according to increased knowledge gathered through monitoring makes structures with the*
364 *greatest capacity for adjustment the most practical where managers are available to manipulate these structures. Components such as providing mudflats during peak shorebird migrations can only be possible where capabilities of structural manipulation is possible (Helmers, 1992).*"

M-11 (M.6. General Limitations of All Structures) - add sentence: "*The continued monitoring that is being conducted on projects through CWPPRA (PL-646) and what is required on all individual projects indicate that the*
365 *more management capabilities originally installed will allow easier modification to either structure itself or the operation scheme as more of these questions are answered. This is especially important with the amount of land being lost as we wait for all the studies to be completed.*"

N Threatened and Endangered Species/Marine Mammals - [*not included, refer to comments made on 50% draft on*
366 *7/19/95, and please send me a copy of latest draft for review when available*]

Inclusion of an Appendix O Species or Groups of Animals of Special Concern is advisable. This could include the following:

367 *Waterfowl*
Migratory Birds
- *Shorebirds*
- *Neotropical Migrants*

[*This was discussed in 50% Draft 7/19/95*]
[*If you desire another copy of those comments, let me know*]

S.2.1.2. U. S. Department of Commerce-

National Marine Fisheries (NMFS)

1. - 2. Disagree, see Chapter 3.0.

3. Noted, see Chapter 4.0. and 5.0. and Appendixes C and Q (especially the tables).

4. Extensive subject treatment throughout F-PHMEIS, Sections 4.2., 4.3.4., 4.3.5.2. (especially 4.3.5.2.3.), 4.3.6.2., 4.3.6.16., 5.5.2.3., 5.5.2.9., 5.5.4., 5.6.2., 5.6.8., 5.6.16., 5.6.21., and 5.8. are responsive.

5. Noted, Tables 4 and 5 eliminated.

6. Comment address land-use determinations. Not a function of this F-PHMEIS or NOD. As for factors considered, see Section 2.0. and the Table of Contents would be insightful.

7. Noted, the document was substantially reorganized, rewritten and expanded in many areas (see for example, 4.) to be responsive to the points raised in the comment.

8. The word "surmise" was used for clarity.

9. Agree, see Chapter 2.0.

10. - 11. Agree, amended.

12. Noted, see Chapter 2.0., especially the definitions.

13. See 1, and Chapters 3.0. and Appendixes C and Q.

14. Amended.

15. Noted, disagree, see rewritten Chapters 2.0., especially Section 2.3.

16. Rewritten, see Chapters 2.0., especially Section 2.3.

17. Generally agree, but see 2.3.11.

18. Agree, see rewritten Sections 4.2.3., 4.3.4., 4.3.6., 4.4.3.6.5., 4.3.6.8.2., 5.6.5., and 5.6.8.

19. Reference to NAWMMP eliminated.

20. Agree, see Section 4.3.5.2.4. and 5.5.2.4.

21. Amended.

22. Agree, see Section 4.3.4.1.1. and Appendix B.

23. Eliminated.

24. Disagree, retained these paragraphs as they establish context/partial basis for disagreement and skepticism.

25. Moved for continuity and context (see Section 4.3.1.).

26. Noted, but see 2.3.4. and Appendix B.

27. Disagree, see 26.

28. Agree.

29. Sections 5.1., 5.2., and 5.8. are responsive.

30. - 31. Noted, citations are largely species specific rather than comprehensive plant community profiles, but see Section 4.3.4.2. and Appendix A.

32. Noted, see 5.1.1.5.3. and 5.3.3.

33. Noted, clarified (see 4.4.1.).

34. Noted, see Section 2.0.

35. Noted, but see Appendix D for response. Note also, that there is a difference between apparent and actual marsh gain.

36. The narrative summaries do what the tables would do and more.

37. See Appendix D, but note also that the Atchafalaya River and Basin were not included in this analysis, have not been the subject of any HM permit action and has not been the subject of any candidate CWPPRA HM efforts.

38. Partly agree (see Section 4.3.3.), but gives emphasis NOD believe appropriate.

39. Agree, see Sections 5.1.1.3., 5.1.1.5., and 5.8.

40. Noted, see 5.1. and 5.8.

41. Noted, partly agree, see Chapter 5.0., especially, Sections 5.1., 5.2. and 5.8.

42. Noted, agree, see Appendixes C and D, and Sections 5.1. and

5.8.

42.1. Addressed in context of cumulative impacts.

42.2. See 37.

42.3. Amended, see Appendix C.

42.4. Noted, see Appendix D.

42.5. Disagree about inclusion of Vermilion Parish w/l 284 Included Vermilion Parish w/l 321 (1995 - Pending)

42.6. See Section 5.3.2.3.

42.7. See Sections 5.3.2.3. and 5.3.3.

42.8. See Section 5.1.1.5.

43. See previous comments about waterfowl, see also Section 5.5.2.8.

44. Noted, amended and rewritten, see especially Sections 5.1.1. and 5.8.

45. Noted, see Section 4.3.4.5.1.2.

46. Noted, see Section 4.3.4.1. and Appendix B.

47. As presented, it was represented as a potential - not a demonstrated - response.

48. Noted, see Sections 4.3.5.1.3.1. and 5.8.

49. Sections 4.3.1. and 4.3.5.1.3.2. are responsive.

50. Disagree, see 1.

51. Noted, see revised Section 4.3.5.1.4.

52. Generally disagree about alleged inadequacy, but agree about suggestions to better readership. See Sections 4.3.5.2., as well as 5.5.2.3. 5.5.2.9., Socioeconomics at 5.6.2., and 5.8.

52.1. Generalized discussion only, but see Appendix E.

52.2. Disagree.

52.3. See Appendix B for similar reference to same issue.

53.4. Amended, see especially Section 4.3.5.2.3.

53. Modified slightly.

54. Agree, amended see Section 4.3.4.1.1.

55. Agree, see Section 4.3.4.1.3.

56. Amended, see Section 4.3.4.6.

57. Amended, see Section 5.4.4.

58. Amended, see Sections 5.1.1.3.1. and 5.4.4.

59. Agree it could be done but see 4.3.5.2.2. for revised treatment.

60. Heading eliminated.

61. Noted, see Sections 4.3.5.2.5. and 5.5.3. and Appendix G.

62. Noted, see Sections 4.3.6.2. and 5.8.

63. Table 4 deleted - see also Chapter 2.0. and 3.0.

64. Sections 4.3.2., 4.3.4.1.3., 4.3.4.5.1.2., 4.3.6.3.1., 4.3.6.3.2., 4.3.6.9.1., 4.4.2.2.1. and 4.4.2.2.2. collectively are responsive.

65. Disagree, see 1.

66. Amended, see Section 5.2. and Appendix Q. Also, the entire list of candidate CWPPRA HM projects was updated by Ms. Sue Hawes, a CWPPRA Basin Captain and NOD CWPPRA team member for NOD.

67. Noted, but see Plates 1 - 8 and Section 5.8.

68. Table 5-20 eliminated, see Sections 5.4. - 5.7. for details.

69. Amended and rewritten, see Section 5.8.

70. Noted, see Section 5.1., Appendix Q and Section 5.8.

71. Noted, amended. See Section 5.8.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

December 12, 1995

Colonel Kenneth H. Clow
District Engineer, New Orleans District
Department of the Army, Corps of Engineers
Attn: CELMN-PD-RS
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Clow:

The National Marine Fisheries Service (NMFS) has received the draft Programmatic Hydrologic Manipulation Environmental Impact Statement (EIS) and Appendices transmitted for our review by letter of October 19, 1995, from Mr. R. H. Schroeder, Jr. The EIS evaluates the impacts of the issuing Federal permits authorizing hydrologic restoration and marsh management projects in coastal Louisiana by the Corps of Engineers' New Orleans District (NOD). The NMFS has reviewed the EIS and offers the following general and specific comments.

GENERAL COMMENTS

As a cooperating agency, the NMFS has consistently recommended that hydrologic restoration not be included in this EIS. The sole purpose in developing this EIS is the need to analyze the impacts of marsh management activities in Louisiana. While we believe hydrologic restoration can be a reasonable alternative to marsh management, it is radically different from marsh management because hydrologic restoration does not include water level manipulation and total isolation from the surrounding watershed is not possible. Furthermore, based on our review of the EIS and our knowledge of hydrologic restoration projects, it is clear that little documentation exists on their impacts and benefits. Including hydrologic restoration in this EIS obscures the focus of the document and makes it needlessly confusing and long. If it is later determined that a programmatic EIS is warranted for hydrologic restoration activities, then one should be developed at that time. 1

The NMFS also disagrees with the presentation of projects identified in the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Restoration Plan as a reasonable representation of future management activities. Based on our participation in the development of the Restoration Plan, many projects were included in the document based on a vague project description and little analysis of the need for the project. We believe it would be more appropriate to assume a certain level of future permit requests for marsh management activities in each basin 2

based on the history of that basin. Specifically, we recommend that the NOD determine the annual acreage of authorized management activities from 1983 through 1994 and, based on the recent trend of reduced numbers of management applications, extrapolate a reduced rate into the future. As indicated, we believe this should be done for marsh management projects alone, and that detailed consideration of hydrologic restoration activities be dropped from this EIS. The NMFS is also concerned that the EIS does not consider data important to the understanding of the cumulative impacts of marsh management in coastal Louisiana. Specifically, the significant acreages of wetlands under management on state and Federal refuges are ignored. There are data available to document acres and type of management on public refuges. While the EIS indicates that refuges in some areas are under management, their areal extent is not included in the analysis of impacts. Those acres should be incorporated into the basin descriptions. 3

The assessment of marsh management impacts on the production of living marine resources is inadequate. This is an especially critical shortcoming because fishery impacts are one of the two most important and controversial issues surrounding marsh management. The production of harvestable fishery resources represents the most valuable renewable resource component of Louisiana coastal wetlands, and is the resource at greatest risk with the implementation of marsh management projects. A much more extensive review, analysis and discussion is warranted. 4

The EIS incorporates, in the analysis of impacts and Table A-2, projects for which permits had expired and either no work had been done or the project had been abandoned. The text and this table indicate these projects had been at least partially implemented. Based on extensive field investigations and discussions with landowners, the NMFS has found that many projects have never been implemented. This situation indicates a serious programmatic marsh management deficiency and a problem that has not been adequately addressed in this EIS. Specifically, there appears to be an extreme lack of oversight of permitted marsh management activities by the regulatory agencies. The NOD apparently does not know which projects have been implemented, or to what extent. Therefore, it is likely that the NOD also does not know if structures are being operated as authorized or if other permit special conditions are being followed. The EIS has pointed out in several locations that compliance with monitoring and reporting conditions was poor. An in-depth discussion should be added to the EIS identifying these oversight and communication problems, how they may impact the various resources discussed in the document, and what remedial measures are available.

The NMFS also believes that the EIS contains much unnecessary information and that it could be significantly shortened without loss of important detail. Recommendations on sections and issues to be dropped are indicated in our specific comments. Furthermore, we find sections of the EIS to be poorly written, with many run-on or unclear sentences, missing data, or grammatical errors. Where these situations may affect the understanding of an important issue in the EIS, we have indicated their location in the specific comments section. Finally, Tables 4-1 and 5-20 are 5

very hard to understand and of limited value. These tables should be deleted or condensed and rewritten to facilitate understanding of the impacts. We believe the sections in those tables addressing marsh management impacts to estuarine-dependent fishery organisms significantly understate those impacts, are misleading, and should be rewritten. The NMFS offers its assistance in these revisions.

Finally, the NMFS is concerned that the EIS reaches no meaningful conclusion and provides no guidance to regulators or the regulated public on situations where marsh management may and may not be appropriate. Thus, the level of predictability in permit issuance has not benefitted from preparation of this document. At a minimum, the EIS should indicate what factors should be taken into consideration for preparation and review of a marsh management permit application, and how those factors could affect a permit issuance decision. 6

In summary, the NMFS believes that the EIS needs substantial revision before it can be considered adequate towards addressing the programmatic impact of marsh management activities in Louisiana. However, our review of the EIS does indicate that NMFS concerns regarding the NOD permitting of marsh management projects is justified. That is: 1) the EIS does indicate there are extensive areas under management in Louisiana; 2) that management adversely impacts marine fishery resources; 3) that there is no real understanding of the short or long term impacts of management on many marsh functions and resources; and 4) that there is inadequate oversight by the NOD of permitted projects that individually impact thousands of acres of coastal wetlands. With this in mind, the NMFS finds it completely unjustified that the NOD can conclude in the EIS that continued consideration and authorization of marsh management activities in Louisiana is in the overall public interest. 7

SPECIFIC COMMENTS

1.0 INTRODUCTION 8

Page 1-2, paragraph 1. This paragraph indicates that solutions to marsh loss reflect consideration of the causes of the loss, while the preceding paragraph indicates that specific causes are generally unknown. Clarification should be provided.

Page 1-2, paragraph 5. The following sentence should be inserted after the first, non-underlined sentence, "Marsh management may also be preferred by an applicant who wishes to have greater control over an area's hydrology than that allowed for by a hydrologic restoration project." 9

The last sentence in this paragraph (page 1-3) appears to suggest that structures are always successful in controlling the quantity of water in a managed area. Based on our experience, because of adverse meteorological conditions, water control structures are only occasionally successful in achieving this control. Therefore, we recommend the phrase "in an attempt" be inserted in the final sentence after the word "manipulated." 10

3.0. ALTERNATIVES

3.1. Perspective

Page 3-1, paragraph 2. The last sentence in this paragraph indicates that marsh managers can use management to successfully control water levels, water chemistry and marsh substrates. As indicated above, this has not often been the case. We recommend this sentence be rewritten to indicate that managers are only occasionally successful in controlling those variables. 11

Page 3-1, paragraph 3. The Herke citation is not identified by a year. This should be rectified.

Page 3-1, paragraph 4. Hydrologic restoration, while being an alternative to marsh management, is not an alternative form of marsh management. We recommend this paragraph be deleted from the text and that this EIS be revised to concentrate solely on marsh management activities and impacts. 12

3.2 Alternatives

3.2.2. Future with Additional Management

3.2.2.1. Assumption About Source, Number and General Concept of Candidate Project Types

Page 3-2, paragraph 6. We disagree with using CWPPRA projects as a model of future conditions in coastal Louisiana. Based on the State's new "big picture" approach and current funding allocations, and the fact that only three marsh management projects out of five priority project lists have been approved for detailed planning, we believe it is unlikely that many of the projects identified in the CWPPRA Restoration Plan will ever be proposed or implemented. Rather, it is more likely that some reduced level of management activity would be proposed and funded by private landowners and parish governments. It would be more appropriate, as discussed in our general comments, to analyze the future with management at an annual rate reflecting permit activity trends from 1983 through 1994. Using this approach, trends by habitat types, etc., impacted by previously authorized projects could be extrapolated to the future-with-management scenario. 13

Page 3-3, paragraph 2. This paragraph indicates that the NOD has received increasing numbers of permit applications for CWPPRA-sanctioned marsh management projects in recent years. Based on our extensive involvement in CWPPRA activities, the only marsh management projects that have been sanctioned (which we define as being approved for detailed planning) by the CWPPRA Task Force are the East Mud Lake, the Browns Lake, and the Highway 384 projects in Cameron Parish. The East Mud Lake project was advertised via public notice in 1990 prior to consideration as a CWPPRA project. The Browns Lake project was advertised in 1993 (and the application has since been withdrawn), and the permit for the Highway 384 project has yet to be applied for. Therefore, we find there is no such trend and recommend this sentence be rewritten or it should be deleted.

The third sentence in this paragraph indicates that several previously permitted projects had been incorporated into, funded, and implemented under the auspices of CWPPRA. The NMFS does not find the Lafourche Parish Wetlands 743 project to be marsh management. Therefore, the East Mud Lake project is the only previously permitted marsh management project to be approved for construction under CWPPRA. The NMFS recommends that this sentence be rewritten to identify actual trends or it should be deleted. 13 cont'd.

3.2.2.4. Assumption About Rate of Project Implementation

Page 3-4, paragraph 2. It is indicated that, for the purposes of this EIS, it will be assumed that all CWPPRA projects included in the future-with-management scenario would be implemented immediately. Use of a reduced annualized rate of project permitting, as recommended and previously described, would allow use of a more realistic assumption. This rate could be extrapolated to 5- or 10-year periods and the impacts analyzed based on those time frames.

4.0. ENVIRONMENTAL, SCIENTIFIC, SOCIOECONOMIC, CULTURAL AND SCIENTIFIC (sic) SETTINGS

4.1 Basic Definitions 14

4.1.1. What is Marsh?

Page 4-1, paragraph 3. This entire paragraph is superfluous and should be deleted.

4.1.4. Implications from the definitions

Page 4-3, paragraph 2. We disagree with the statement that the marsh management definitions oblige managers to favorably affect the vegetated landscape. The definitions indicate that marsh management is for the purpose of improving productivity. The degree to which management succeeds in reaching that goal is varied and may actually adversely impact the vegetative landscape. This sentence should be revised to indicate that managers attempt to favorably affect vegetation or selected marsh-dependent resources. 15

The second sentence in this paragraph is long and difficult to understand. We recommend this sentence be rewritten into shorter, more coherent, sentences.

4.1.5. Marsh erosion and marsh deterioration.

Page 4-4, paragraph 1. We strongly disagree with the misleading use of the term "marsh erosion" when referring to a change in plant communities. Using this definition, an area could actually be experiencing a gain in emergent vegetative coverage, but an applicant could request a management permit with "marsh erosion" prevention as justification. The term "marsh erosion" should only be used when referring to a net loss in coverage of emergent vegetation. The last sentence in this paragraph should be deleted. 16

4.1.6. Synthesis

Page 4-4. This entire section is redundant and unnecessary. As such, we recommend that it be deleted. Also, the last paragraph offering the NOD perspective indicates a conclusion that would better be stated near the end of the EIS. 17

4.2. The Socioeconomic and Cultural Setting - Who is Concerned About Marsh Losses and Why
4.2.2. Attributes of General Social and Economic Significance
4.2.2.2. Mineral Value

Page 4-6, paragraph 3. The NMFS believes that the statement made in the last sentence regarding the loss of a landowner's right to reclaim mineral rights is incorrect. We consulted with Mr. Jim Wilkins, an attorney with the Sea Grant Legal program, who reviewed the applicable law (Louisiana Revised Statute 41:1702b). The statute indicates that if the landowners reclaim the eroded land, then they retain the underlying mineral rights. The sentence should be rewritten to correctly reflect landowner rights. 18

4.2.2.3. Marsh-dependent Resources with Socioeconomic Significance 19
4.2.2.3.2. Waterfowl

Page 4-7, paragraph 6 through Page 4-8, paragraph 3. The NMFS agrees that waterfowl use of coastal marshes is important socioeconomically in Louisiana. However, the lengthy discussion of the purpose and implementation of the North American Waterfowl Management Plan (NAWMP) in Louisiana is unnecessary. This section should be shortened to one paragraph detailing the general purpose of the NAWMP and indicating in general how it impacts marsh management for waterfowl. In addition, the primary issue impacting waterfowl numbers nationwide is a shortage of nesting habitat in north America. It should be indicated that there is presently sufficient feeding and resting area in coastal Louisiana for all waterfowl using the Mississippi and Central flyways and that the NAWMP projects inn Louisiana mainly produce shifts in the location of waterfowl.

4.2.2.3.3. Fur and Hides

Page 4-9, paragraph 1. This paragraph should identify those specific resources targeted for their fur and hides; e.g., nutria, muskrat, otter, and alligator. This paragraph also should indicate that the harvesting of furbearers currently provides little economic incentive to landowners due to reduced demand which causes low pelt prices. 20

4.3 Evolution of Marsh Management in Louisiana 21
4.3.1. Why Marshes Were First Managed

Page 4-11, paragraph 3. This entire seven-line paragraph contains only one sentence and is difficult to understand. It should be rewritten into shorter, more coherent, sentences.

Page 4-11, Paragraph 4. Wording in this paragraph and in other sections of the EIS indicate that hydrologic conditions within managed areas can be controlled independently of seasonal water levels and other physical conditions. Based on numerous conversations with marsh managers, many attempted drawdowns are not successful and many management areas experience periodic failure of levees and water control structures, thereby further impacting the success of management efforts. We believe it should be stated in this section that successful water level control is dependent largely on all perimeter structures being intact and in working order and on meteorological conditions that provide optimal conditions for water level control. It also should be indicated that active management of water levels is often not achieved, because of excess rainfall, inadequate tidal cycles, or poor structural control. 22

Page 4-12, paragraph 1. The meaning of the final sentence is unclear. We recommend it be rewritten to clarify the relationship that is mentioned. 23

4.3.2. An Additional Emphasis Emerges

Page 4-12, paragraph 3. It is suggested that the success of marsh management for controlling habitat conditions has been well documented. As indicated in paragraph 1 on page 4-13, this is not a widely accepted premise. The historical perspective should be revised to accurately portray the state of marsh management science in the past two decades or this section should be deleted. 24

4.3.4. Modern Marsh Management Strategies

Page 4-15, paragraph 3. Statements made here assume a level of monitoring that presently does not occur. As indicated in subsequent sections of the EIS, monitoring historically has been inadequate and below levels required in permits. It is likely that future analysis of modern marsh management impacts will be based solely on the studies presently being undertaken by the National Biological Service or on future CWPPRA monitoring of the East Mud Lake management area and the Highway 384 project (if implemented). Therefore, neither of the two sentences in this paragraph are supported by fact and we suggest this paragraph be deleted. 25

4.3.5. The Design of Current and Future Management Efforts

4.3.5.1. Marsh Management

4.3.5.1.1. Passive Marsh Management 26

Page 4-16, paragraph 1. An additional sentence should be added at the end of the paragraph to indicate that communication between managed and unmanaged marshes is severely reduced even when water levels are above the weir crest elevations.

4.3.5.1.3. Hydrologic Restoration

Page 4-16, paragraph 3. As indicated previously, including a review and assessment of hydrologic management projects in this EIS reduces the document's effectiveness in evaluating the impacts of marsh management activities. Therefore, this section should be deleted. 27

4.4. Geologic, Physical, Meteorological and Chemical Environments of Louisiana's Coastal Marshes

Page 4-22, paragraph 1. This paragraph is poorly written and difficult to understand. We recommend that the lengthy sentences be rewritten to provide shorter, more coherent concepts. In addition, the second sentence indicates that managers have conclusively documented how management impacts several disparate hydrologic factors. If this is the case, then citations for each factor should be provided for documentation. If supporting documentation is not available, the sentence is speculative and should be deleted. 28

4.5. Louisiana's Coastal Marsh Types and Their Associated/Dependent Biological Resources

Pages 4-23 through 4-29. Trends within basins, between basins and coastwide for vegetation, salinity, and soil types are discussed at length in this section. However, based on our review of the entire document, this trend information is not utilized in the analysis of marsh management. Because some trends may be useful for determining in which basins, portions of basins, or soil or marsh types management may be more, or less, appropriate, Chapters 4 and 5 should be revised to synthesize this information and include conclusions and recommendations based on the data synthesis. 29

4.5.1. Fresh Marsh
4.5.1.3. Flooding Depths and Durations

Page 4-24, paragraph 3. This paragraph indicates that no compilation of species specific responses to increased levels and durations of flooding exist. However, Nyman and Delaune (1991), Pezeshki et al. (1987a), and Mendelssohn and McKee (1987) reported on these factors for various fresh marsh plant species. We recommend that this paragraph be rewritten to briefly summarize the results of their research. 30

Similar statements are provided under the "Flooding Depths and Durations" heading for each of the other marsh types (Section 4.5.2, 4.5.3, and 4.5.4.). However, Pezeshki et al. (1987a) for intermediate marsh; Burdick (1989), Burdick et al. (1989), and Nyman and Delaune (1991) for brackish marsh; and Mendelssohn and McKee (1987, 1988) and Nyman and Delaune (1991) for saline marsh, provided research information on the impacts of flooding on plant species for those marsh types. The major findings of each author concerning flooding impacts for plant species in those marsh types should be summarized.

4.5.1.4. Salinities

Page 4-24, paragraph 6. It is indicated that no single compilation of species specific responses to increased salinity levels exist. While no single document may report on the effects of salinity on many fresh marsh species, Mendelssohn and McKee (1987), and Pezeshki et al. (1987b, 1991), provided research information on the impacts of salinity on various fresh marsh plant species. We recommend that this paragraph be rewritten to briefly summarize the results of their research.

Similar statements are provided under the "Salinities" heading for each of the other marsh types. However, we believe Pezeshki et al. (1987a) for intermediate marsh; Koch and Mendelssohn (1989), Mendelssohn and McKee (1987), and Pezeshki et al. (1987c, 1991) for brackish marsh; and Mendelssohn and McKee (1987) and Webb (1983) for saline marsh, provided information on the impacts of salinity on plant species for those marsh types. The major findings of each author concerning salinity impacts for plant species in those marsh types should be summarized. 31

4.5.5. Synthesis

Page 4-30, lines 2-6. The sentence beginning "Thus, management . . .," appears to be making an important statement on the uncertainty of management success. However, we find the sentence confusing and recommend that it be rewritten to clarify the statements made. 32

4.6. Marsh (Land) Loss

Page 4-30, paragraph 3. Successive sentences related to rates of land loss conflict. Data indicate that land loss during the most recent period of record in most basins is significantly less than previous periods. Therefore, we recommend that the third sentence be deleted and that the final sentence be rewritten to indicate that, while losses were high in the 1960's and 1970's, the loss rates in recent years have decreased to about half of what they were previously. 33

4.6.1. Marsh Erosion and Marsh Deterioration

Page 4-31, paragraph 1. As indicated previously, the use of the term "marsh erosion" is inappropriate when referring to the colonization of open water areas by vegetation that does not attract waterfowl. As such, we recommend that the final sentence in this paragraph be deleted. 34

4.6.4. Historic Marsh Loss Rates/Deterioration

Page 4-32, paragraph 6. Data being used to determine marsh loss rates do not allow for an estimate of marsh gain. That is, open water areas that become marsh are not recognized as such in the database because they remain classified as water. Therefore, it should be recognized that marsh loss rates in some areas (e.g., near Atchafalaya Bay or close to freshwater diversions) may not be as great as stated in the EIS. 35

Pages 4-33 through 4-36. We recommend that a tabular presentation of actual loss rates in acres for each basin and for each period of record be provided. This would allow readers to know the actual loss rates and, by referring to the table instead of written descriptions of changes for all periods of record, may allow the text to be shortened. In addition, based on a visual review of the locations of marsh loss for each period or record, we recommend that an attempt be made to determine the percentage of internal loss as compared to shoreline erosion. 36

4.6.4.1.5. Basin 6 - Atchafalaya

Page 4-34, paragraph 1. It is indicated that about 9% of the 1932 land mass in this basin has converted to open water. As previously advised, this in an artifact of a database that does not recognize situations where open water has reverted back to marsh. Because of the emergence of the Wax Lake and Atchafalaya deltas, the wetland area of the Atchafalaya basin has likely increased since 1932. This situation should be indicated and an estimate made of the actual acres within Atchafalaya Bay in 1990, as compared to 1932. Data from the Louisiana Department of Wildlife and Fisheries may be useful in this endeavor. 37

4.7. An Overview of the Written Record

Page 4-36 through 4-43. Many of the citations have been identified and discussed previously. Data and citations necessary to support statements in the EIS should be provided where those comments are made. This section could then be deleted.. 38

4.8. Where Science and Society's Interests Meet
4.8.2. General Discussion of NOD's Permit Data

Page 4-47, lines 5-7. The sentence beginning on line 5 indicates that monitoring required as a permit condition was intended to provide insight into the success of management. However, it should also be indicated that monitoring was also intended as a tool to determine the need for project design and operation revisions. In addition, it should be noted that monitoring was seldom undertaken as required and rarely provided useful insight into management impacts or necessary remedial measures. 39

4.8.2.1. Compilation

Page 4-47, paragraph 4. The first sentence in this paragraph is unclear and should be rewritten. 40

4.8.2.3. Permit Landscape Patterns

Page 4-50, paragraph 2. Based on our review of the EIS, the use and description of landscape patterns provides no meaningful information to analyze marsh management. Unless a greater level of analysis can be provided or patterns can be shown to be useful in reaching permit decisions, this section and all future descriptions of landscape patterns should be deleted.

4.8.3. Correspondence with Stipulated Purpose

Page 4-51, paragraph 4. This paragraph indicates that through the use of photographic records of a managed area, one might conclude that management was successful if no marsh loss can be detected. This reasoning is faulty. Just because a managed area does not appear to have suffered wetland loss over a period of time does not necessarily reflect management success. Only a comparison of the managed area with an adjacent and similar unmanaged area can allow an analysis of possible management impacts. Additional study would be required to relate observed differences to management practices. This paragraph, or a new paragraph to follow, should provide a discussion, based on the scientific method, of the utilization of maps and photographic records of a managed area towards determining marsh loss and success of management. 41

4.8.3.1. Delta Region/Basins
4.8.3.1.1. Pontchartrain Basin

Pages 4-52 through 4-54. Based on our records, four of the marsh management permits identified as being at least partially installed were either never installed or have been abandoned. Permits for each of those projects have expired. Yet another, while having a valid permit, has yet to be implemented. We believe any discussion of management impacts in this basin should be limited to the one implemented project.

Marsh loss data for some projects during various periods of record also are discussed. A table showing loss rates for all projects in all basins during each period of record should be provided. This would allow the reader to determine when marsh loss was highest in each area and whether management based on the need to slow erosion was warranted. Furthermore, because most management projects have been justified based on an attempt to slow marsh loss, a discussion should be provided in this section and in all other basin sections indicating which projects were experiencing high loss rates during the time period that management actions had been applied for. 42

4.8.3.1.2. Breton Basin (Basin 2)

Pages 4-54 through 4-55. Three of the four permits discussed in this section have expired and the work authorized was never implemented. Therefore, all discussions related to marsh management impacts in this basin should only focus on the Delacroix Corporation management area. The text should be revised accordingly.

4.8.3.1.3. Barataria Basin (Basin 4)

Pages 4-55 through 4-60. As in the other basins, there are several projects listed where the permits had expired and little or no work had been done. Therefore, a new permit would have to be applied for to implement management activities on those areas. We recommend that all discussions related to marsh management impacts be limited to those that have been implemented.

4.8.3.1.4. Terrebonne Basin (Basin 5)

Pages 4-60 through 4-62. The Pointe au Chien Wildlife Management Area is under active management. We recommend that the acreage included within that management area be added to those in this basin and that all discussions be revised accordingly. 42.1

Page 4-60, paragraph 5. This paragraph describes the relationship between management areas and historic marsh loss and indicates that all but one of the management activities are located in areas of high marsh loss. The entire central and eastern portions of this basin are experiencing high marsh loss rates. Therefore, correlating the location of a management area with a need to slow erosion may not be appropriate. A discussion of marsh loss trends in this basin should be added.

4.8.3.1.5. Atchafalaya Basin (Basin 6)

Page 4-62, paragraph 5. This section should discuss the general permit issued to the Louisiana Department of Wildlife and Fisheries for marsh management in the Atchafalaya Refuge. 42.2

4.8.3.1.6. Teche-Vermilion Basin (Basin 7)

Page 4-63 through 4-65. Two marsh management projects were not included in the analysis of impacts for this basin (Vermilion Parish Wetlands 297 and Dugas Canal 8). These projects should be added to the table and included in the text discussion. In addition, permits for several other projects in the basin have expired and no features of those projects have been implemented. Therefore, they should be dropped from any discussion of marsh management impacts. 42.3

Many areas that were formerly marsh north of the Gulf Intracoastal Waterway are now impounded and utilized for rice farming or crawfish culturing. Because this affects the analysis of cumulative impacts, this fact should be briefly discussed in this section. 42.4

4.8.3.2. Chenier Region/Basins
4.8.3.2.1. Mermentau Basin (Basin 8)

Pages 4-67 through 4-71. Two marsh management projects were not included in the analysis for this basin (Vermilion Parish Wetlands 284 and Vermilion Parish Wetlands 321). These projects should be added to the table and included in the text discussion. Also, Rockefeller Refuge 42.5

contains a large area of marsh, most of which is under active or passive management. To adequately understand the magnitude of the cumulative management impacts in this basin, that acreage should be added to the table and included in the discussion of impacts and trends.

Furthermore, our files indicated that about 50% of what formerly was tidally influenced marsh adjacent to the Mermentau River is now impounded and managed for cattle, waterfowl, or aquaculture, and at least another that 20% is under some other form of management. These acreages are not reflected in any permit identified in the table. Because these activities affect the analysis of cumulative management activities in this basin, this issue should be presented early in the discussion for this basin. 42.

4.8.3.2.2. Calcasieu-Sabine Basin (Basin 9)

Pages 4-71 through 4-74. Most of the Sabine National Wildlife Refuge west of Calcasieu Lake is either impounded or under passive management. To adequately understand the magnitude of the cumulative management impacts in this basin, the acreage of the Refuge should be added to the table and included in the discussion of impacts and trends. 42.

4.7.3.2.4. Coastwide Summary

Page 4-75, paragraph 5. This paragraph erroneously suggests that "project patterning" in five basins implies that ecological implications would not extend beyond management area boundaries. This should be revised to indicate that impacts to the production and harvest of estuarine-dependent fisheries can extend well beyond specific management areas.

4.8.4. Trends Noted From the Previously Issued Permits 42.8

4.8.4.1. Relative to Marsh Loss

Page 4-76, paragraph 2. This paragraph indicates that most project sites encompassed areas that had undergone marsh loss. This is not surprising considering that most of coastal Louisiana has historically experienced various rates of marsh loss. We recommend that this fact be noted here. Additionally, it should be noted that marsh loss in many management areas was relatively low during the time period that management activities were requested.

4.8.4.2. Relative to Waterfowl

Page 4-76 through 4-78. This section is meant to be a synopsis of the coastwide trends of management towards improving waterfowl habitat. As such, too much detail has been provided on specific projects in various basins. Because this information has already been provided, we recommend that this section be abbreviated to describe only the general statewide trends. 4

4.8.6. Measuring Management Successes

Pages 4-78 through 4-80. This entire discussion focuses on monitoring being undertaken to measure management success. However, it does not indicate that much of the monitoring is not scientifically based; i.e., it does not compare variables in managed and unmanaged sites. Additionally, this section does not indicate that monitoring of implemented marsh management projects frequently is not done. A new paragraph should be added after the first paragraph in this section discussing the inadequacies of the monitoring effort in general and indicating what percentage of the permitted projects actually were being monitored. This would allow readers to understand the limitations of the monitoring effort discussed in the remainder of this section.

4.9. Significant Resources and Management
4.9.1. Marsh Soils
4.9.1.2. Persistence

Page 4-82, paragraph 2. The meaning of the last sentence in this paragraph is unclear and should be rewritten. 45

Page 4-83, paragraph 1. Reed (1992), Reed and McKee (1991), and Cahoon and Groat (1990) reported that marsh management significantly reduced sediment import and accretion in managed marshes. These findings should be reported in this paragraph.

Page 4-83, paragraph 2. This paragraph indicates the importance of cold fronts to sediment dynamics in coastal Louisiana. Data from Cahoon and Groat (1990) indicate that, during winter cold fronts, water levels do not change in managed areas. By reducing the volume of water entering the management area, the structures also impair sediment import from outside the management area. This impact should be identified and discussed. 46

Page 4-83, paragraph 5. This paragraph indicates that management enhances root zone expansion, thereby offsetting marsh surface elevation reductions. Such a management impact has not been demonstrated. Therefore, we recommend that the first three sentences in this paragraph be deleted or that evidence be shown that this phenomenon predictably occurs in managed, but not unmanaged, marshes. 47

4.9.2. Emergent Vegetation on Native, Uneroded Soils

Page 4-86, paragraph 1. While in some situations management has been correlated with the expansion of emergent vegetation, in others it has been demonstrated to impair plant growth and survival, as well as expansion. The final sentence in this paragraph should be rewritten to indicate that management of some areas has been demonstrated to adversely impact vegetative health and expansion. 48

4.9.3. Emergent Vegetation on Eroded but Exposable Soils

Page 4-87, paragraph 3. Based on our interviews of marsh managers, we believe successful drawdowns result from less than 50% of all attempted drawdowns. This should be indicated in this paragraph and a discussion should be provided on the factors necessary to initiate and maintain a drawdown for enough time to allow plant germination and growth. 49

Page 4-87, paragraph 4. The first sentence in this paragraph is unclear and should be rewritten. This sentence also appears to discuss hydrologic restoration projects that include water level reductions. By definition, hydrologic restoration projects cannot include a water level reduction component. Therefore, we recommend that this comment be deleted. 50

4.9.6. Soils of Marsh Ponds

Page 4-90, paragraph 2. This paragraph refers to recent work by investigators suggesting that frequent drawdowns impact marsh sediment dynamics. Citations to document this statement should be provided for this sentence, or the sentence should be deleted. 51

4.9.7. Fish

Pages 4-91 through 4-96. This entire section inadequately addresses potential management impacts to marine fishery species, even though fishery impacts represent one of the most contentious marsh management issues. This section of the EIS should be rewritten. The importance of Louisiana's coastal marshes as nursery and foraging areas should be stressed. Data should be added indicating when most active management projects implement drawdown activities, and which economically important fishery species are excluded from the managed area during those seasonal periods. Data quantifying the impacts of management on all major fishery species also should be added to the text. Because NMFS staff in Baton Rouge have greater expertise in this subject and are knowledgeable of potential management impacts, we offer to assist in this effort. 52

Page 4-91, paragraph 5. The first paragraph in this section is valueless and should be deleted.

Page 4-91, paragraph 7. The first sentence in this paragraph is unclear and should be rewritten. In addition, we disagree with the proposed profiling of fishery organisms. We believe this breakdown should be based solely on life history requirements and potential management impacts. Specifically, we recommend that the categories be: 1) smaller, marsh resident species that are found in fresh to brackish marsh habitats; 2) fresh water species that may become either a part or full-time resident of a managed area; and, 3) estuarine-dependent marine species. Thereafter, the discussion of fishery impacts should be separated among these categories and potential impacts of management on each category should be more fully discussed.

Page 4-92, paragraph 2. The discussion of fishery immigration patterns is in error. Immature forms of marine fishery species enter marsh nursery areas in Louisiana year-around. While brown shrimp and blue crab immigrate to the marsh during most of the year, young of at least a few species immigrate into Louisiana's coastal marshes during all seasons. This paragraph should be rewritten to accurately reflect immigration patterns. 52.1

Page 4-92, paragraph 3. The third sentence is unclear and should be rewritten.

Page 4-93, paragraph 1. Browder et al. (1989) reported a positive relationship between penaeid shrimp harvest and the length of the marsh interface. This citation also should be presented and discussed in this paragraph. 52.2

Page 4-94, paragraph 1. The research conducted by Herke and others is inadequately presented. Findings relating to the significance and magnitude of the impact to fishery production was not indicated. Herke's study in the Cameron-Creole watershed indicated greater than 70% reductions in production of most economically-important marine fishery species as a result of a fixed crest weir set at 12 inches below marsh level (Herke et al. 1987). This study found that gulf menhaden production was reduced by an average of 93%. Lost production figures should be identified and discussed in this paragraph. Additionally, the point should be made that many management structures and operational schemes restrict fishery organisms even greater than those reported by Herke.

Page 4-95, paragraph 1. This paragraph is unclear. It should be broken into shorter, more coherent sentences with a clear meaning. 53

4.9.11. Hydrology: Water

Page 4-106, paragraph 1. The last sentence is incomplete and should be clarified. 54

4.9.13. Hydrology: Salinity

Page 4-107, paragraph 4. This paragraph indicates that there has been a general inland advance of salinity over the years. However, the first sentence in paragraph 5 states that there is no compelling evidence for any on-going trend of increasing salinity. Based on the studies cited, we believe the latter statement is true and recommend that the final sentence in paragraph 4 be rewritten or it should be deleted. 55

4.9.17. Nutrients

Page 4-113, paragraph 5. This paragraph discusses water temperatures trends in coastal marshes. Because water temperature is not a "nutrient," we recommend that this paragraph be moved to a more suitable location. 56

Page 4-113, paragraph 6, through Page 4-113, paragraph 3. These paragraphs primarily discuss dissolved oxygen levels, with no relationship to the "Nutrients" heading. Only discussions related to how dissolved oxygen impacts nutrient availability should be provided in this section. Those paragraphs that only discuss dissolved oxygen levels should be deleted or moved to a more appropriate location in the document.

Page 4-116, paragraph 2. This paragraph indicates that Cahoon and Groat (1990) did not include an analysis of nutrient dynamics in managed marshes. Pages 384 through 399 in Cahoon and Groat (1990) include a comparison of measured nutrient fluxes between managed and control marshes. In addition, the section from pages 440 through 482 include soil nutrient comparisons between two managed and unmanaged areas. Therefore, we recommend that this sentence be deleted and that a summary of the findings of the referenced report, as they relate to nutrients, be provided in this paragraph. 57

4.9.18. Primary Production

Page 4-116, paragraph 6. This paragraph indicates that Cahoon and Groat (1990) did not address the matter of overall primary production between managed and unmanaged marshes. However, the section of their report beginning on Page 440 titled, "VEGETATION AND SOIL RESPONSE TO MARSH MANAGEMENT," measured many plant variables related to primary production, as well as net above ground primary productivity and overall primary production. This paragraph should be rewritten to summarize the findings of Cahoon and Groat (1990) as they relate to primary production. 58

4.9.19. Secondary Production
4.9.19.2. Benthos

Page 4-123, paragraph 2, through page 4-124, paragraph 3. Discussions related to research findings of Wenner (1986a,b) and Olmi (1986) concern management impacts on fish and decapod crustaceans. As such, they are more appropriate in the Fish section (Page 4-91). The NMFS recommends that all discussions related to these citations be moved to appropriate locations in that section. 59

4.9.19.3. Wildlife and Fish, Crabs and Shrimp

Page 4-125, paragraph 1. The purpose of this paragraph is unclear. All topics identified in the heading are discussed in previous sections. Conclusions stated in this paragraph should be identified in the final paragraph for each individual section and this paragraph should be deleted. 60

4.9.20. Marine Mammals and Threatened and Endangered Species

Page 4-125, paragraphs 2 and 3. No mention is made in this paragraph of endangered sea turtles and the potential management impacts. We recommend that this section be rewritten to identify the species of sea turtles found in Louisiana coastal waters, and discuss their use of coastal marshes and the potential impacts of marsh management. This section should specifically indicate that the nearshore area of the Chenier Plain is an important foraging and staging area for the Kemp's ridley sea turtle, and that these turtles have been sighted in Calcasieu and Sabine Lakes, as well as in canals on the Sabine National Wildlife Refuge (Will Nidecker, personal communication). 61

4.9.21. Socioeconomics
4.9.21.1. Fish and Wildlife Resources
4.9.21.1.2. Recreational

Page 4-126, paragraph 6. The last sentence in this paragraph indicates that the economics of recreational and commercial fishing have been contrasted, but gives no information on the results of that effort. This sentence should be rewritten to discuss any findings. 62

4.9.21.1.3. Management Implications

Page 4-127, paragraph 1. This paragraph indicates that one implication of management on economically important resources is that related economic interests can be prolonged if management can successfully stop or reverse marsh loss. Other management implications should be identified. At a minimum, it should be stated that management that does not significantly reduce wetland loss may not be justified because of the magnitude of the adverse impacts on economically important fishery resources.

Table 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES

Pages 4-137 through 4-173. As indicated in our General Comments, the NMFS strongly disagrees with the inclusion and analyses of hydrologic restoration activities in this EIS. Therefore, our review of Table 4-1 is limited to the marsh management alternative only. Many management assumptions described in the EIS and contained in the table are incorrect, misleading, and confusing. Because this table is confusing and does not further the understanding of marsh management alternatives, we recommend that the entire table be deleted from the document. If the NOD determines the table to be necessary, the NMFS requests the opportunity to assist in revision of the table, or at least to review and recommend changes prior to issuance of a final EIS. 63

5.0. IMPACTS AND EFFECTS OF PRIOR AND FUTURE ACTIONS

This chapter of the EIS should be expanded to discuss the long-term implications of high rates of subsidence on the long-term success of marsh management activities that depend on gravity flow to dewater and flood marshes in coastal Louisiana. Similarly, potential impacts of hurricanes on the success of marsh management should be addressed (see Conner et al. 1989). 64

5.1. CWPPRA Projects, Land Loss and Permits

Page 5-2, paragraph 4. The use of CWPPRA projects to identify future marsh management or hydrologic restoration activities is inappropriate. Because of the preponderance of projects, shortage of funds, and the allocation of the majority of CWPPRA monies towards "big picture" projects, it is unlikely that even a small portion of the marsh management projects identified in the Restoration Plan will ever be implemented. It is more reasonable to expect an approximate rate of marsh management applications based on the previous application history of each basin. That is, basins that have historically supported large numbers of marsh management projects will probably experience greater emphasis towards marsh management than basins having few projects. Considering 1) the reduction in petroleum exploration activities and the concomitant reduction in mitigation needs; 2) the difficulty and expense engendered in receiving a marsh management permit and maintaining a functional project; and 3) the recent reduction in permit applications for management activities, the NMFS believes it is reasonable to expect that the rate of marsh management proposals in the future will be less than that which has occurred historically. Therefore, we recommend that the NOD use as a future estimate of activity an annual rate equal to 50% of the historic (1983 through 1994) rate of permitted marsh management projects. Furthermore, incorporation of this assumption into the EIS would render unnecessary the CWPPRA project descriptions in Section 5.1. 65

5.1.1. Delta Basins
5.1.1.3. Barataria Basin
5.1.1.3.2. Profiles of Individual Barataria Basin CWPPRA Projects

Page 5-9, paragraph 3. This paragraph indicates the PBA-34 project area is 3,300 acres in size. However, based on our review of the Barataria Basin figure in this EIS, the project area appears to be much greater. In addition, based on our knowledge of this project, the benefitted area is north of the Bayou L'Ours ridge rather than to the south. These discrepancies should be reviewed, and all figures and data should be changed to reflect actual numbers and areas. 66

5.1.1.4. Terrebonne Basin
5.1.1.4.2. Individual CWPPRA Project Profiles

Page 5-14, paragraph 1. The PTE-23/XTE-33 project (Lake Chapeau Marsh Creation and Hydrologic Restoration) is sponsored by NMFS and was approved for detailed planning on the

Third Priority Project List. This project consists of using 500,000 cubic yards of dredged material to create marsh in an 1,800-acre area, the installation of 7 plugs and one low sill rip-rap structure in oil field access channels, and the gapping of spoil banks at strategic locations. As such, there is no active operation component to this project. This paragraph should be corrected accordingly.

The final sentence in this paragraph indicates that the only hydrologic connections which the managed area would retain with outside areas would be what occurred through the rock weirs and over the marsh during high tide. This statement is incorrect. All natural bayous will remain open. The intent of this project is to plug or reduce man-made openings that have widened and deepened to become major water exchange routes and, as a result, have captured flow from natural channels. With the project installed, water will continue to flow to the project area through the smaller bayous, as had occurred prior to man's actions. This sentence should be revised to reflect actual project expectations.

66 cont'd.

Page 5-20, paragraph 1. The PTE-22/24 project sponsored by NMFS was approved for funding on the Second Priority Project List, and is under construction at this time. The final sentence in this paragraph indicates that hydrologic communications between the managed and outside areas would be restricted to what would occur only during high tides. This statement is incorrect. All bayous that flow from the outside into and across interior project-area marshes will remain open. This sentence should be revised to reflect actual project design conditions.

5.1.2. Chenier Basins
5.1.2.1. Mermentau Basin
5.1.2.1.3. CWPPRA - Mermentau Basin Summary

Page 5-29, paragraphs 2 and 5. These paragraphs indicate that actively operated hydrologic restoration would be among the management options of choice in this basin. However, based on our review of the Restoration Plan, all of the identified projects consist of active marsh management. All projects identified as likely to be implemented in this basin should be termed as "active marsh management" and all such discussions should be revised accordingly.

5.1.2.2. Calcasieu-Sabine Basin
5.1.2.2.2. Profiles of Individual Calcasieu-Sabine Basin CWPPRA Projects

Pages 5-31 through 5-48. Several projects (PCS-25; CS-14; XCS-48/SO-5; XCS-47/48i,j,k,p; and CS-2) have been identified in this section as being active hydrologic restoration projects. However, based on our review of the Restoration Plan, these projects are, or are likely to be, more "active marsh management" in nature. Therefore, these projects should be re-classified as "active marsh management" and all summaries at the end of the section should be revised accordingly.

Some projects also have not been identified as being "hydrologic restoration" or "marsh management." All projects discussed in this section be identified by appropriate project type.

5.1.2.2.3. CWPPRA - Calcasieu-Sabine Basin Summary

Page 5-50, paragraph 1. This paragraph indicates that implementation of CWPPRA projects would result in 6,457 additional acres of this basin being actively managed in the future. However, many CWPPRA projects identified as hydrologic restoration are, in fact, marsh management. Additionally, based on our experience in the Chenier Plain, were these projects to be fully developed and a Section 10/404 permit applied for, the description of the management components would be far different from that tentatively identified in the Restoration Plan. We recommend that the NOD revise this figure to indicate a more accurate accounting of marsh management acreage in the CWPPRA plan. 66 cont'd.

5.1.3. Coastwide Summaries
5.1.3.2. Future With Permits and CWPPRA

Page 5-54, paragraph 1. As noted previously, to allow a cumulative assessment of marsh management impacts from permitting activities, all acreages under management by Federal, State, and private interests should be considered. 67

Table 5-20

Pages 5-57 through 5-91, As with Table 4-1, this table is misleading and extremely confusing. As an alternative, we recommend that identified cumulative impacts be presented in text form and that the table be deleted. 68

In discussing cumulative marsh management impacts in Basins 7, 8, and 9; only for Basin 9 is it indicated that a significant commitment to management has been made. However, when considering State wildlife refuges and structures installed prior to permitting requirements, we find that all three basins have significant percentages of their areas being managed. Therefore, we recommend that all statements which indicate that only Basins 4, 5, and 9 have significant acreages involved in management, be revised to include Basins 7 and 8. To allow an adequate cumulative impact assessment for all basins, an estimate of the acreage of coastal wetlands with no or restricted access to estuarine-dependent fishery resources should be presented. 69

Under the COASTWIDE section in this table, the statement that, "Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond to management for at least one growing season" is provided frequently and is misleading. It is frequently not possible for marsh management projects to control the hydrology of an area

sufficiently to achieve a beneficial impact. This has not been discussed in the text. This statement should be reworded and included in the text to indicate that on those occasions when adequate hydrologic controls can be achieved and sustained "this significant attribute . . . ."

Page 5-66. DELTA BASINS AND REGION, paragraph 1. This paragraph indicates that management has resulted in shifts in numbers, biomass and species. With deletion of this table, the text should indicate that economically important marine fishery species are those most adversely impacted by management due to their exclusion from management areas.

5.3 Synthesis

Page 5-92. A paragraph should be added indicating that many management proposals were received and authorized for areas that were not currently experiencing significant rates of marsh loss. A discussion on the suitability of implementing marsh management projects for the purpose of reducing marsh loss in areas not experiencing erosion or marsh loss should be included. 70

5.4. Conclusions

Pages 5-94 through 5-95. It is stated on page 5-94 that, "Consideration of the facts suggests that in some instances, in certain areas and/or for certain purposes, marsh management can be, and hydrologic restoration has the potential to be, highly effective and may result in minimal adverse impact, whereas in other circumstances management efforts may be ineffective at best and can be detrimental to one or more significant resources either locally or on a much broader scale." With such insight, the Conclusions section, or possibly the preceding Synthesis section, should provide guidance, based on best available data, research findings, and monitoring, on factors that may influence management success, and situations where management would be appropriate or inappropriate. It would be especially helpful to analyze the data to identify potential marsh management applicability based on geographic considerations (e.g., potential success and comparative impacts in the upper vs. lower portions of the coastal basins). 71

The NMFS appreciates the opportunity to review the EIS. The NMFS's Baton Rouge Field Branch offers its assistance as a cooperating agency in the revision of selected sections of the document.

Sincerely,

Andreas Mager, Jr.
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Office of the Secretary for Oceans and Atmosphere

1. Noted, CD-ROM forwarded to NOD Regulatroy Functions Branch for future reference.

2. Noted, request forwarded to NOD Regulatory Functions Branch for future action.

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

January 24, 1996

U.S. Army Corps of Engineer
New Orleans District
Attn: Robert Rosenberg
CELMN-PD-RS
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Mr. Rosenberg:

Enclosed are comments on the Draft Environmental Impact Statement for Programmatic Hydrologic Manipulation New Orleans, Louisiana. You have received comments directly from the National Marine Fisheries Service. We hope our comments will assist you. Thank you for giving us an opportunity to review the document.

Sincerely,

Donna Wieting

Donna S. Wieting
Acting Director
Ecology and Conservation Office

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

DEC 1 1995

MEMORANDUM FOR: Donna Wieting
Ecology and Environmental Conservation Office
Office of the Chief Scientist

FROM: for Captain Lewis A. Lapine, NOAA
Director, National Geodetic Survey

SUBJECT: DEIS-9510-09 --Programmatic Hydrologic Manipulation New Orleans, Louisiana

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in Louisiana is provided on the CD-ROM accompanying this memorandum. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project include the cost of any relocation(s) required.

For further information about these monuments, please contact John Spencer, NOAA, NGS, N/NGS, 1315 East-West Highway, Silver Spring, Maryland 20910, telephone 301-713-3169, fax 301-713-4175.

With regards to the U.S. coastal zone in this area, the proposed dredging and construction of levees, culverts, rock weirs, wave dampening devices and other water control structures discussed in this Draft Environmental Impact Statement and designed to stem marsh losses and shoreline erosion at specific sites could affect the portrayal of shoreline on all NOS nautical charts of the Louisiana coast, Lake Pontchartrain, Mississippi Sound, Chandeleur Sound, Breton Sound and the north bank of the Mississippi River. Interior marshes and shoreline along the Intracoastal Waterway will also be affected.

The proposal calls for restoration of the wetlands and encouragement of the regeneration of cypress. Much of this effort is in the planning stages. Existing conditions of eight designated hydrologic subdivisions in Louisiana are summarized in this document, whereby problem areas are identified and tentative projects are designed to improve the situation. The foremost desired effects of this management is to protect the local estuarine fisheries and preserve and encourage the growth of submerged aquatic vegetation.

2 cont'd.

Retaining enough water in the managed area to facilitate recreational and commercial activities is a desired effect, however, improved navigation is not a direct objective. The impact on safe navigation is undetermined. The limits of any Fish and Wildlife Sanctuaries established in this region as a result of this environmental restoration effort would probably be charted along with appropriate caution notes. The text of U.S. Coast Pilot 4 referencing the Gulf Coast may have to be amended upon completion of the projects.

NOAA requests U.S. Army Corps of Engineers to furnish any surveys upon completion of these multiple projects so that any related shoreline changes can be accurately detailed on future editions of affected NOS charts. Please provide copies of any surveys within this project to: Howard Danley, NOAA, Office of Coast Survey, N/CS28, 1315 East-West Hwy, Silver Spring, Maryland 20910.

Attachments

S.2.1.3. U. S. Department of the Interior, Fish and Wildlife Service (FWS)

1. Noted, proposed actions taken as opportunities permitted.

2. Disagree, see Chapters 2.0. and 3.0.

3. Disagree, the suggested modifications are an exercise in the management refinement process, an aspect of the evolution of HM that properly occurs outside the EIS process (disclosure of impacts about existing and future management proposals).

4. - 5. Noted.

6. Appendix B corrected.

7. Corrections to eliminate overlaps were made (see Appendix Q);

conceptual nature of projects acknowledged (se Section 3.2.2.); see Chapter 3.0., especially Section 3.2.4. concerning assumed number of projects assumed implemented.

8. Note, Chapters 4.0. and 5.0. were sequenced as suggested.

9. Noted, see Section 4.1.

10. Agree, see Chapter 2.0., especially Section 2.3., and elsewhere throughout the document.

11. Noted, Sections 4.3.4.1.2., 4.3.3.3., 4.3.4.5., 4.3.5.1.3., and 5.6.6.3. are responsive.

12.1. Appendix D is responsive.

12.2. The information sought is presented in the CWPPRA appendixes for each basin and is cited in the F-PHMEIS as such.

13. See 12. and Appendix D for rebuttal.

14. Disagree, the Atchafalaya Basin was not included in the F-PHMEIS because it has not been the site of any HM permit actions and is not the subject area for any CWPPRA HM efforts.

15. See 13 and 14.

16. Noted, agree, see 4.4.2.2.3.

17. Agree, see Section 5.1.1. and Appendix C.

18. Noted, see Sections 5.4.5.2. and 5.4.5.3. and 5.8.

19. Corrected, see Table C-6, in Appendix C.

20. Noted, and addressed (for example Sections 4.3.4.1.2. and 4.3.4.7.).

21. - 22. Agree, see Section 5.4.4.2.

23. Noted, but see subsequent paragraphs of same section in F-PHMEIS.

24. Noted, see Sections 4.3.5.2.5. and 5.5.3., Appendix G and also Chapter 6.0.

25. See 16.

26. Table 4 eliminated, but note sequencing of Chapters 4 and 5, which are responsive to this comment. See also Sections 4.3.4.1. and 4.3.5.1.3.1.

27. Agree, see Appendix B.

28. The F-PHMEIS is substantially reorganized and resequenced compared with the D-HMEIS in a way that is responsive to this comment.

29. Noted, see also Sections 5.3.3., 5.4., 5.5., and 5.8.

30. Agree, see Sections 4.3.5.1.3. and 4.3.5.1.4.

31. Noted, see Section 4.3.5.2.3. and Appendixes B and E.

32. Corrected.

33. Disagree, must be consistent with "worst case".

34. Corrected.

35. - 37. Noted, necessary correction made. See Table C-4, Appendix C.

38. - 39. Noted.

40. Noted and corrected.

41. - 42. Noted and corrected.

43. Appropriate action taken. See Appendixes C and Q, and corresponding section in Chapters 4.0. and 5.0.

44. Amended as appropriate.

45. Amended as appropriate, carried forth as components.

46. Noted.

47. - 48. Amended as appropriate.

49. Disagree, carried forth as components.

50. Noted, amended as appropriate.

51. Noted.

52. Disagree, it fits the definitions.

53. Disagree, due to added effects.

54. Noted, but does not agree with NRCS's River Basin Plan narrative.

55. - 56. Corrections made.

57. Disagree, see Chapters 2.0. and 3.0.

58. Table 5-20 eliminated. See Chapter 2.0. for explanation and Chapter 5.0. for details.

59. Agree, see Sections 5.4. - 5.8.

60. See 5.8., but much would be policy formulation, which is beyond the scope of this PHMEIS.

Other: Comments 34 - 54 are taken as evidence of a continuing interest in pursuing HM projects throughout coastal Louisiana.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Post Office Box 649
Albuquerque, New Mexico 87103

IN REPLY REFER TO:

February 20, 1996

ER 95/865

U.S Army Corps of Engineers,
New Orleans District
ATTN: Robert Bosenberg
CELMD-PD-RS
P.O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Bosenberg:

The U.S. Department of the Interior has reviewed the Programmatic Hydrologic Manipulation Draft Environmental Impact Statement (DEIS) and Appendices. In this regard, we provide the following comments for your consideration.

General Comments:

The document should provide more information on the effects of marsh management. Document length should be reduced by deleting 1 Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) project descriptions, summarizing permit data, and eliminating redundancies. We believe that the DEIS substantially overestimates future managed acreage. 2 Also, the effects of the various alternatives to marsh management are not sufficiently addressed. The document should provide more information regarding the circumstances under which marsh management may be beneficial or detrimental to marshes. 3 Management practices and project features that could be used to increase management effectiveness and reduce adverse impacts should also be identified.

Specific Comments:

Page 3-1, Section 3.1., Paragraph 1 - Historic marsh management 4 activities were often conducted to provide boat access for harvesting wildlife.

Page 3-1, Section 3.1., Paragraph 2 - The fifth sentence 5 incorrectly indicates that the active management strategy preserves boat access throughout the area; drawdowns may actually prohibit boat access.

Page 3-1, Section 3.1., Paragraph 3 - Fixed-crest weirs function 6

year-round, not seasonally.

Page 3-3, Section 3.2.2.1. Paragraph 3 - Some marsh management
and hydrologic restoration projects listed in the CWPPRA
Restoration Plan overlap or serve as alternatives to one another.
Many CWPPRA restoration project proposals are conceptual and may
prove to be impractical. Furthermore, the permit evaluation
process may eliminate some projects or reduce their impacts
and/or affected acreage. Perhaps the greatest reason why the
future-with-management assumption is highly questionable is the
uncertainty over CWPPRA reauthorization, and changing policies 7
regarding the types of projects to be funded by CWPPRA. Given
those uncertainties, we believe that assuming full implementation
of CWPPRA Restoration Plan projects over-estimates the future
acreage of marsh management and hydrologic restoration projects
in coastal Louisiana (see also comments on Page 3-4, Section
3.2.2.4., Paragraph 1, and Sections beginning with 5.1.). The
maximum acreage affected by the future-with-management scenario
would be more realistically estimated by extrapolating the
acreage affected by the last 3 to 4 years of issued permits,
which includes CWPPRA and non-CWPPRA projects.

Page 3-4, Section 3.2.2.4. Paragraph 1 - The assumption of
immediate and total implementation of CWPPRA projects is highly
questionable. In each of the last 4 years, between 11 and 54
percent of the construction funds allocated by the Louisiana
Coastal Wetlands Conservation and Restoration Task Force (Task
Force) have been obligated for a combination of marsh management,
hydrologic restoration, and outfall management projects. At that
rate, only a small percentage of the marsh management and
hydrologic restoration projects listed in the Restoration Plan
will have been funded by the time CWPPRA funding ceases to
accumulate (i.e., at the end of Fiscal Year 1997).

Page 4-1, Section 4.0., Paragraph 2 - The order in which
subtopics are discussed is confusing, and redundancies occur. To
enhance understanding of marsh management and its potential 8
effects in coastal Louisiana, coastal geomorphology and
ecosystem-level processes should be discussed first, followed by
marsh loss, social and economic impacts of marsh loss, marsh
management (definitions, objectives, and types), and pertinent
permit information.

Page 4-6, Section 4.2.1., Paragraph 2 - The third sentence is
misleading, as extensive hydrologic alterations throughout the 9
Louisiana coastal zone have substantially altered wetland
functions. The sentence should be revised as follows,
"Louisiana's coastal marshes are complex, hydrologically driven,
extensively altered habitats."

Page 4-16, Sections 4.3.5.1.2. and 4.3.5.1.3. - The DEIS should 10
further discuss the differences between hydrologic restoration

and marsh management, and between passive and active hydrologic restoration.

Page 4-17, Section 4.4., Paragraph 4 - The geomorphology discussion in this section should address wetland maintenance and deterioration processes of abandoned deltaic lobes, by habitat type. The relative importance of organic matter versus mineral matter accumulation should be discussed. Kosters et al. (1987) is a good reference for the less-saline environments. Maintenance processes of inland Chenier Plain marshes should also be discussed. 11

Page 4-30, Section 4.6., Paragraph 3 - Human alterations (e.g. sediment starvation, saltwater intrusion via man-made channels, impoundment, development, and direct losses due to canal construction) should be discussed. 12.1 To better appreciate the impacts of those alterations, the DEIS should also provide, in table form, marsh type acreage over time, by basin. 12.2

Page 4-33, Sections 4.6.4.1 through 4.6.4.2.3 - The data should include marsh acreages by habitat type. The Corps of Engineers' (Corps) data set does not illustrate wetland losses attributed to conversion to terrestrial habitats, nor does it show wetland gains. Because the U.S. National Biological Service's (NBS) data set is not affected by those problems and can be used to determine net changes, we recommend that NBS data also be presented. Studies which suggest causes or identify trends regarding wetland loss patterns should also be summarized. Such studies include Gagliano and Wicker (1988), Dozier et al. (1986), Turner (1987), and Gosselink et al. (1979). 13

Page 4-33, Section 4.6.4.1., Paragraph 1 - A section addressing the Mississippi River Delta Basin should be included. NBS wetland acreage data should be presented for this basin; pease feel free to contact them at National Biological Service, Southern Science Center, 700 Cajundome Blvd., Lafayette, LA 70506, (318) 266-8501 to obtain this information.

Page 4-34, Section 4.6.4.1.5., Paragraph 1 - Because of recent wetland gains in the Atchafalaya Basin, NBS wetland acreage data should also be presented. 14

Page 4-34, Section 4.6.4.1.7., Paragraph 1 - Since wetland gains are occurring in the Mississippi River Delta Basin and the Atchafalaya River Basin, NBS data should be provided to show net changes in wetland acreages.

Page 4-35, Section 4.6.4.2.2, Paragraph 2 - Wetland gains have occurred in portions of the Calcasieu/Sabine Basin since the late 1970s. The most substantial gains occurred in managed areas during the late 1980s and early 1990s. The NBS data should be used to illustrate net changes in wetland acreages; those data 15

include the western portion of the basin not included in the Corps' data set.

Page 4-36, Section 4.6.4.2.3., Paragraph 2 - Some of the specific areas of man-made wetland loss discussed are marsh impoundments which were deliberately managed to open up solid marshes to improve waterfowl habitat quality. Other areas of apparent loss may be abandoned and flooded agricultural impoundments.

Page 4-36, Section 4.6.4.2.3, Paragraph 3 - The last two sentences suggest that wetland losses west of Calcasieu Lake between 1932 and 1974 occurred within "...formerly impounded and managed areas." These sentences do not accurately present the effects of marsh management activities and the cause of marsh loss west of Calcasieu Lake. We recommend that the last two sentences be replaced with the following. 16

> Three marsh impoundments were constructed on Sabine National Wildlife Refuge during the 1950s. Those areas were initially managed to open up solid stands of emergent vegetation and thereby improve habitat for fish and wildlife. The remaining marshes on the Refuge, and marshes extending northward from the Refuge toward Hackberry, were unmanaged until water control structures were installed in 1980 at Hog Island Gully, Headquarters Canal, and West Cove Canal to reduce saltwater intrusion from the Calcasieu Ship Channel. Marsh loss occurred within both impounded and unmanaged areas between 1932 and 1974; however, the majority of those losses occurred in unmanaged areas. Marsh losses west of Calcasieu Lake also occurred concurrently with extensive marsh losses east of Calcasieu Lake, implicating construction and enlargement of the Calcasieu Ship Channel as a major cause.

The NBS wetland acreage data should be provided to show that marsh losses were being partially offset by marsh gains in both managed and unmanaged areas during the 1980s and 1990s.

Page 4-48, Section 4.8.2.2., Paragraph 2 - To more accurately quantify the acreage of managed marshes, more information is needed regarding project construction, completion, and abandonment. Cahoon et al. (1990) determined that project construction commenced on approximately 34 percent of permits issued by the State of Louisiana, and that construction was completed on approximately 8 to 12 percent of all permit applications submitted to the State. This differs greatly from the Corps' estimate that construction was begun on 85 percent of permitted projects. The Corps' data should be corrected using permit data collected by the National Marine Fisheries Service and the Louisiana Department of Natural Resources' Coastal Management Division; remaining discrepancies should be presented and discussed. 17

More information is needed regarding the acreage of managed marshes on State and Federal properties. Approximately 106,850 acres of Federally owned marshes (all in Cameron Parish) are in total impoundments constructed by the U.S. Fish and Wildlife Service (FWS), or are actively managed. 18

Page 4-63, Section 4.8.3.1.6., Paragraph 4 - The Bayou Cassmer 1 project was never constructed. 19

Page 4-84, Section 4.9.1.2., Paragraph 1 - We recommend that the following sentences be added at the end of the paragraph.

> In sediment-poor areas, however, unregulated water exchange may introduce little sediment and cause stress to vegetation via high salinities or excessive and fluctuating water levels. Under such conditions, managers may seek to reduce or eliminate water exchange to promote revegetation and/or increase production and accumulation of organic matter by reducing salinities, water levels, or both. 20

Page 4-85, Section 4.9.2., Paragraph 4 - The text should state that the frequency and duration of drawdowns are often shortened to reduce adverse impacts to fisheries and other wetland functions, while still benefitting vegetation. 21

Page 4-87, Section 4.9.3., Paragraph 3 - See above comments regarding Page 4-85, Section 4.9.2., Paragraph 4. Drawdowns do encourage colonization of mudflats by perennials through seed germination and vegetative propagation. Hess et al. (1989) and Klett and Paille (1994) observed that such colonization is most rapid in fresh and intermediate marshes; little perennial colonization was observed in brackish marshes. 22

Page 4-91, Section 4.9.7. - Freshwater fishes should also be discussed. 23

Page 4-125, Section 4.9.20., Paragraph 1 - The threatened and endangered species which might be affected by management of coastal marshes should be listed. Those species include sea turtles, bald eagle, brown pelican, piping plover, and the West Indian manatee. The DEIS should also determine whether marsh management and hydrologic restoration activities would result in an adverse impact to the above-mentioned species; if so, a biological assessment should be provided. 24

Page 4-129, Section 4.9.21.8.2., Paragraph 1 - The statement regarding management of National Wildlife Refuges should be replaced with the following sentence:

> The management of most of those refuges is focused on providing high quality habitat for overwintering waterfowl, as well as habitat for other migratory birds, threatened and 25

endangered species, and some resident species.

Page 4-137, Table 4-1 - The information presented in this table should be the major theme of the document and provide the most detailed findings regarding the effects of marsh management and other alternatives. Some of this information is also repeated in the sections beginning with 4.9. The use of a tabular format for this section is unwieldy and results in incompleteness and confusion. Information should also be provided regarding the no-action alternative and other management alternatives such as sediment trapping, freshwater diversion, and shoreline protection. This information should be presented in text form and in greater detail with references. 26

Because hydrology is the primary forcing function in Louisiana's coastal marshes, the effects of management alternatives on hydrology should be discussed first, followed by effects on other non-biotic components and processes. The effects on vegetation should summarize much of the information presented earlier. Effects on fish and wildlife should follow effects on vegetation. Habitat related differences should also be discussed where known. The section dealing with the no-action scenario should address what would occur in the absence of new marsh management or hydrologic restoration projects.

Effects of prolonged management on marsh health should also be discussed. The impoundments on Rockefeller Refuge and Sabine National Wildlife Refuge are examples of long-term management.

It should be clearly stated that marsh management effects depend heavily on water control structure operation. It may, therefore, be possible to substantially alter the management-area responses by simply changing structure operation. Changes in the number and design of structures may also cause different management-area responses. 27

Page 4-137, Table 4-1 - Management effects on nutrient availability, salinity, sulfates, salinity fluctuations, soil redox potential, and other aspects of soil biochemistry should be addressed. Vegetative responses such as productivity, reproduction, and root penetration should also be discussed. Those responses may vary depending upon whether vegetation is being affected by submergence, unintentional impoundment, salinity increases, canal-induced hydrologic alterations, or other stresses. Because management effects and the associated vegetative responses may vary with these factors, they should be discussed at least briefly. 28

Page 4-139, Table 4-1 - Where water levels are not reduced to expose eroded areas, management-induced salinity reductions may allow fresh marsh vegetation, such as cattail, bulltongue, bullwhip, and giant cutgrass, to colonize shallow open water 29

areas by vegetative propagation. This was observed by Klett and Paille (1994). Similar processes have occurred in unmanaged marshes west of Calcasieu Lake where excessive rainfall reduced salinities during the early 1990s. See also comments for Table 4-1, Page 4-137.

Page 4-142, Table 4-1 - Dense submerged aquatic vegetation may reduce wave energy and associated physical erosion of marsh edges, especially where marsh soils are highly organic. Submerged aquatic vegetation may also reduce eroded material export during outgoing tides. 30

Page 4-147, Table 4-1 - The text should provide quantitative data on the impacts of fixed-crest weirs on productivity of estuarine-dependent fisheries. Where active management allows less water exchange than fixed-crest weirs, the impacts would likely be more severe than that of fixed-crest weirs. Where actively managed structures allow more water exchange, impacts to estuarine fisheries might be less, but have not yet been measured. Those impacts may also vary greatly depending upon structure operations. Hess et al. (1989) suggests that shrimp recruitment into actively managed areas may be enhanced by refilling the areas during periods when post-larval and juvenile shrimp are abundant. Impacts to freshwater fisheries should also be discussed. 31

Page 5-9, Section 5.1.1.3.2., Paragraph 2 - Because of the severe shoreline erosion along Bayou Rigolettes, CWPPRA project BA-14 may never be constructed. Table 5-3 indicates that the project area includes the existing 450-acre management area (Jefferson Parish Wetland 192). Since its acreage is included in that of permitted projects (Appendix J, Table 1.3.), it should be subtracted from the acreage which would be affected by project BA-14. 32

Page 5-9, Section 5.1.1.3.2., Paragraph 4 - According to the text, project PBA-34 would affect 3,300 acres. Table 5-3 suggests, however, that this area includes marshes previously permitted for management. This conflict should be resolved and corrections made to avoid overestimating the acreage affected by CWPPRA project implementation.

Page 5-13, Section 5.1.1.4.2., Paragraph 1 - Project PTE-26b includes several actively managed structures. Those structures are of minor importance; the project should be categorized as passive hydrologic restoration. 33

Page 5-14, Section 5.1.1.4.2., Paragraph 2 - The area that would be affected by project PTE-23/XTE-33 overlaps somewhat with PTE-22/24; hence, the future CWPPRA-related acreage is overestimated. 34

Page 5-14, Section 5.1.1.4.2., Paragraph 3 - Active management

components of projects TE-5a and TE-5b have been installed and are operating. Consequently, TE-5d is being affected like that of a passive hydrologic restoration project. Hence, areas in projects TE-5a, TE-5b, and TE-5d are under management and should be deleted from the CWPPRA project total. The 26,500-acre proposed TE-10/XTE-49 project completely encompasses the areas that would be affected by projects TE-5c, TE-9, and XTE-47/48. Projects XTE-58 and PTE-25 would be located largely within TE-10/XTE-49 but would affect an additional 3,200 and 3,840 acres, respectively.

<u>Page 5-15, Section 5.1.1.4.2., Paragraph 2</u> - Project TE-6 would be located in an oyster-producing area and may experience implementation difficulties. 35

<u>Page 5-15, Section 5.1.1.4.2., Paragraph 3</u> - Project TE-7 encompasses the entire 46,000-acre Lake Boudreaux Basin. Project TE-7a has been permitted as Terrebonne Parish Wetlands 943, but not implemented. The text lists its size as 5,000 acres, but Table 1.3. lists it as 4,100 acres. This area is counted twice since it is included as CWPPRA acreage and permitted acreage. Not to be confused with project TE-7a is an adjacent 456-acre permitted and implemented project, Terrebonne Parish Wetlands 478. The acreage of that project is correctly listed in the permitted acreage. Project TE-7b is the recently permitted 3,000-acre Lashbrook project (Terrebonne Parish Wetlands 953). 36
Its acreage is also counted twice since it is included as both CWPPRA acreage and permitted acreage. Project TE-7c is located in the outfall area of the Chris Lane Pump Station and extends northward to Bayou Butler. We are not aware of a permit being issued to manage this area. Table 5-4 incorrectly lists this project as being permitted via Terrebonne Parish Wetlands 953. Project TE-7d is not a subset of the basin, but involves the entire basin; hence, it is synonymous with TE-7. The 20,015 acres affected by the Boudreaux Canal Weir (Boudreaux Canal 7), a passive hydrologic restoration project, should also be included with the permitted acreage.

<u>Page 5-16, Section 5.1.1.4.2., Paragraph 3</u> - The acreage that would be affected by project TE-19 (reference Public Notice Terrebonne Parish Wetlands 1043) is counted twice, i.e., as CWPPRA acreage and as permitted acreage. 37

<u>Page 5-17, Section 5.1.1.4.2., Paragraphs 2 and 3</u> - Projects XTE-56 and XTE-57 would be located within oyster-producing areas (Melancon et al. 1995) and may, therefore, experience implementation problems. 38

<u>Page 5-17, Section 5.1.1.4.2., Paragraph 4</u> - Comments regarding project XTE-47/48 are included with those for Page 5-14, Section 5.1.1.4.2., Paragraph 3. 39

Page 5-18, Section 5.1.1.4.2., Paragraph 2 - Comments regarding project TE-9 are included with those for Page 5-14, Section 5.1.1.4.2., Paragraph 3. 39 cont'd.

Page 5-18, Section 5.1.1.4.2., Paragraph 3 - Comments regarding project XTE-58 are included with those for Page 5-14, Section 5.1.1.4.2., Paragraph 3.

Page 5-19, Section 5.1.1.4.2., Paragraphs 2 and 3 - Project XTE-29 would be located in a prime oyster-producing area (Melancon et al. 1995) and, therefore, would likely never be constructed; it is also located entirely within the hydrologic restoration project XTE-60. Therefore, the inclusion of both project acreages double-counts the area affected by project XTE-29. 40

Page 5-20, Section 5.1.1.4.2., Paragraph 2 - The area affected by project PTE-22/24 has been counted twice, i.e., under totals for permitted projects and CWPPRA projects. The affected acreage should only be counted under one of those categories.

Page 5-24, Section 5.1.1.5.2., Paragraph 3 - Project TV-8 has likely been permitted under General Permit 21 and implemented. If so, its affected acreage should not be included as a future CWPPRA project. 41

Page 5-31, Section 5.1.2.2.2.1., Paragraph 1 - Project PCS-25 would place 560 acres under active management, and the remainder under passive hydrologic restoration. 42

Page 5-34, Section 5.1.2.2.2.2.2., Paragraph 2 - The text incorrectly states that the area affected by project XCS-47/48ijp was once a "...closed, managed marsh system." This area was first placed under management (active hydrologic restoration) in 1980 and remains under management. Nevertheless, the area has always had free water exchange with the Sabine Lake estuary. This managed area (at least 41,857 acres) should be included with permitted acreage. Any overlap, however, between this project and Cameron Parish Wetlands 863 and Cameron Parish Wetlands 963, as suggested in Table 5-7, should be eliminated. 43

Page 5-35, Section 5.1.2.2.2.2.2, Paragraph 2 - The area affected by project XCS-46 has been reduced to 5,400 acres, all located within a currently managed area. Table 5-7 should, therefore, indicate that no additional unmanaged acreage would be affected by this project. 44

Page 5-35, Section 5.1.2.2.2.2.2, Paragraph 3 - The text incorrectly states that area SA-1 is regulated with variable-crest weirs. This area is a subdivision of the existing XCS-47/48ijp project area and is managed primarily by two radial-arm tainter gates. Areas SA-1a and SA-1b are total impoundments where management is largely independent of adjacent management

areas. Additionally, the perimeter of SA-2 has not been maintained in at least 15 years and possibly much longer.

Page 5-36, Section 5.1.2.2.2.2.3., Paragraph 1 - Projects CS-9, CS-8/48(NO-2a), XCS-48(NO-5), and PCS-14 all lie within the area that would be affected by project XCS-53. Hence, in Table 5-7, only the acreage for XCS-53 should be counted (to avoid duplication). The NO-2a area was counted as both permitted and CWPPRA acreage. The affected area should, therefore, be subtracted from the CWPPRA project acreage (project XCS-53) since it is included in the permitted acreage (see Appendix J, Table 1.3.). 45

Page 5-37, Section 5.1.2.2.2.2.3., Paragraph 2 - Comments regarding projects CS-8/XCS-48(NO-2a and NO-5) are included with those for Page 5-36, Section 5.1.2.2.2.2.3., Paragraph 1. 46

Page 5-38, Section 5.1.2.2.2.2.3., Paragraph 1 - Of the areas listed, project CS-2 (the Rycade Canal structure) influences only project XCS-48(SA-1). Since CS-2 is an implemented non-CWPPRA project, its acreage should be removed that of CWPPRA projects listed in Table 5-7. 47

Page 5-38, Section 5.1.2.2.2.2.3., Paragraph 3 - Project PCS-14, the Kelso Bayou structure, would affect the same areas that would be affected by XCS-53 and not that of project XCS-47/48ijp. Since the area has already been included in the CWPPRA project total, no new acreage would result from implementation of PCS-14. 48

Page 5-39, Section 5.1.2.2.2.2.3., Paragraph 2 - Project CS-5a/12 overlaps that of projects XCS-48(NO-15 to NO-21). The acreage affected by CS-5a/12 should, therefore, be deleted from Table 5-7. 49

Page 5-43, Section 5.1.2.2.2.2.5., Paragraph 1 - The acreage affected by PCS-10 overlaps that of projects CS-5a/12 and XCS-48(NO-17 to NO-21). The area affected by PCS-10 should, therefore, be deleted from Table 5-7. 50

Page 5-44, Section 5.1.2.2.2.2.5., Paragraph 2 - Project area XCS-48(SA-4) is affected by existing water control structures on Sabine National Wildlife Refuge. Water exchange presently occurs through spoil bank gaps on all sides of this area. Benefits to this area would occur indirectly via other projects and no additional hydrologic management of this area is planned as part of this project. It is, therefore, incorrect to state that the area would become "...a managed freshwater impoundment...." 51

Page 5-44, Section 5.1.2.2.2.2.5., Paragraph 3 - Project XCS-48(SA-6) is not a true hydrologic restoration project and its area should not be included in the CWPPRA-project total. 52

Page 5-45, Section 5.1.2.2.2.2.5., Paragraph 3 - Approximately half of the 23,100-acre XCS-48(SA-5) project is currently being passively managed; hence, the acreage that would be affected by the proposed project should be reduced by that amount. 53

Page 5-46, Section 5.1.2.2.2.2.5., Paragraph 2 - Project XCS-48(SA-7) would be operated passively, not actively. 54

Page 5-47, Section 5.1.2.2.2.2.6., Paragraph 1 - Project XCS-48(SO-1) was estimated by Natural Resources Conservation Service (NRCS) personnel to encompass 42,650 acres. Some of that area is presently under management, and another 6,749 acres have recently been permitted for management (Public Notice CESWG-CO-RN, Permit Application 20051). 55

Page 5-47, Section 5.1.2.2.2.2.6., Paragraph 3 - NRCS has estimated that project XCS-48(SO-2) encompasses 22,200 acres. Approximately half of that area would be affected by the management components of the project. 56

Page 5-52, Section 5.1.2.3.2, Paragraph 1 - In addition to the problems discussed above, other serious problems exist regarding the assumption that all CWPPRA-listed projects would be implemented. See comments for Page 3-3, Sections 3.2.2.1., Paragraph 3, and Page 3-4, Section 3.2.2.4., Paragraph 2. 57

Page 5-57, Table 5-20 - The cumulative effects information would be more readable if presented in text form. Information on vegetation of eroded soils, uneroded soils, and open water areas is redundant and should be consolidated. The following statement occurs at the top of some columns, "Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the significant attributes...." This sentence suggests that the acreage within parenthesis is the average size of permitted projects. This statement should be edited to clarify its meaning. A table should be used to list the current acreage of unmanaged and managed marshes by basin, management type, and habitat type. Similar information should be presented for the future-without-management, future-with-management, and future-with-other-restoration scenarios. This would be the most important information available for quantifying cumulative effects. 58

Greater emphasis should also be placed on forecasting the effects of the no-action and the future-with-management alternatives on fish and wildlife. Those forecasts should be based on recent trends in harvest data and/or population estimates and anticipated changes in habitat quantity and quality. Additionally, cumulative effects on adjacent unmanaged marshes under the future-with-management scenario should also be discussed. 59

Page 5-94, Section 5.4., Paragraph 2 - The circumstances under which marsh management may succeed or fail should be discussed. 60

It should also be reiterated that management effects can vary greatly depending upon structure number, size, design, and operation. The text should also briefly mention management features, practices, and structure operations that may be used to enhance management effectiveness and decrease adverse impacts, especially to estuarine-dependent fishes and shellfishes. 6.6 cont'd.

We appreciate the opportunity to review this DEIS. We apologize for providing these comments late but trust they will assist in the development of the final document.

Sincerely,

Glenn Sekavec

Glenn B. Sekavec
Regional Environmental Officer

LITERATURE CITED

Cahoon, D., R. Hartman, and F. Zeringue. 1990. Chapter 7: Marsh management plan profile. In Cahoon, D.R. and C.G. Groat, editors. 1990. A study of marsh management practice in coastal Louisiana, Volume II, Technical Description. Final Report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-30410. OCS Study/MMS 90-0075. 309 pp.

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Kosters, E.C., G.L. Churma, and A. Bailey. 1987. Sedimentary and botanical factors influencing peat accumulation in the Mississippi Delta. Journal of the Geological Society, London. 144:423-434.

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Biol. Rep. 85(14). 58 pp.

S.2.1.4. U. S. Environmental Protection Agency (EPA)

1. - 5. Noted, no action required.

6. - 7. Noted, see revised Chapter 2.0., especially Section 2.0., and Section 5.8.

8. Noted, see 6. - 7., and Appendix P.

9. Noted, see Chapters 2.0. and 3.0.

10. Noted, results of SAB not available, no action taken.

11. Noted, sections of this F-PHMEIS are substantially reorganized, rewritten and resequences, in response to this general comment.

12. Noted, the tables were eliminated in response to this general comment. Narrative discussions were in used instead. See, for example, Chapter 5.0.

13. Noted, see 8.

14. Disagree, see especially Sections 5.1., 5.3. - 5.8.

15. Agree, see Section 5.1., and Appendix Q.

16. Noted, see Chapter 2.0.0. and 30.0., especially Section 3.2.1.

17. Noted, see Sections 5.3. - 5.8.

18. Noted, see 12.

19. Noted, see Sections 3.2.1. and 5.3 - 5.8.

20. Disagree, see Chapter 5, especially 5.1 and 5.2.

21. Noted, disagree, see Chapter 5.

22. Noted, agree. The kind of information referenced could be insightful. However, unlike the civil works project planning process, where that information is required to perform a benefit/cost analysis, such information is not required in the permit process.

23. Noted, see Section 2.3.

24. See Chapter 2.0., especially Section 2.3., and Tables C. and Q.

25. - 26. Noted, see Sections 5.1. and 5.1.1., and 5.8.

27. Noted, thank you for the suggestions. See, also Chapter 2.0. Section 2.0., and Section 5.8.

28. Noted, agree....see Sections 2.3.3. and 2.3.5.

29. Noted, see Sections 5.6.8., 5.6.21.

30. Noted, see Section 4.4. and Appendix D.

31. - 32. Noted, passage amended... see Section 4.3.4.5.1.2.

33. Noted, see Section 4.3.4.1.

34. Noted, but one function of embankments of semi-impoundments is to exclude water. When water levels rise to overtop those embankments, the hydrologic integrity of the embankments as "exclusion" structures" is compromised.

35. Noted, see 12.

36. Noted, see Section 5.4.5.

37. Noted, see Chapter 4.0. especially Section 4.3.4.1.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

February 7, 1996

Colonel Kenneth H. Clow
District Engineer, New Orleans District
U.S. Army Corps of Engineers
Attn: CELMN-PD-RS
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Colonel Clow:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas, has completed its review of the U.S. Army Corps of Engineers, New Orleans District's (NOD) Draft Programmatic Hydrologic Manipulation Environmental Impact Statement (DPHMEIS) for coastal Louisiana. This programmatic document examines marsh management and hydrologic restoration projects that are implemented or proposed for marsh restoration, erosion control, or wildlife enhancement for Louisiana's wetlands. 1

We classify your proposed action and DPHMEIS as "EC-2," i.e., EPA has "Environmental Concerns" to the proposal and requests additional information in the FPHMEIS. The basis for our concerns and the additional information needed in the FPHMEIS include: 1) the development and full consideration of the document's objectives, 2) clarification in the development of future scenarios of CWPPRA projects, and 3) consideration of cumulative and secondary impacts. 2

Detailed comments regarding these concerns and others are provided in an enclosure to assist you in the preparation of the Final Programmatic Hydrologic Manipulation Environmental Impact Statement (FPHMEIS). We invite the opportunity to discuss our comments with your staff at your convenience, if necessary. Please contact Mr. Rob Lawrence or Ms. Yvonne Vallette at (214) 665-2258 or (214) 665-6420 respectively, for any questions or assistance on this matter. 3

Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions.

We appreciate the opportunity to review the DPHMEIS. We request that you send our office five (5) copies of the FPHMEIS at the same time that it is sent to the Office of Federal Activities, (2251A), EPA, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460.

Sincerely yours,

Samuel Coleman

Samuel Coleman, P.E.
Director
Compliance Assurance and
Enforcement Division

Enclosure

cc: Cliff Rader, OFA
Clay Miller, OWOW

DETAILED COMMENTS
HYDROLOGIC MANIPULATION
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

INTRODUCTION

Although nearly a decade has passed since the inception of this EIS, the need for a programmatic review of hydrologic manipulation is still evident with the emerging science of wetland restoration and the growing number of wetland restoration projects proposed by individuals for wetlands management and by agencies under the authority of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). The premise in preparing a programmatic EIS is clear; it allows a comprehensive consideration of an agency's actions and programs, a broader look at alternatives and long-range effects. It also invites serious planning commitments towards the consideration of future activities by a lead agency. 5

DEVELOPMENT OF DOCUMENT OBJECTIVES

While this programmatic document is extremely broad in its consideration of a large geographic area (coastal Louisiana) and a variety of wetland manipulation, restoration, and enhancement activities, EPA has concerns in that the document fails to provide any substantive conclusions that can be used by the Corps to develop a systematic approach in evaluating proposed hydrologic manipulation projects in coastal Louisiana. 6

A basic concern that should be addressed in the FPHMEIS is how NOD plans to use this document and the information gained from its development. The DPHMEIS does not indicate any specific objectives that were to be accomplished by the development of this document nor how it is intended to support NOD's regulatory and decision-making process in evaluating hydrologic manipulation projects. The document does not offer any direction or commitment towards the development of guiding principals or a policy statement by NOD for evaluating future marsh management and/or hydrologic restoration projects. Although the DPHMEIS states that preparation of this document was not intended to develop a policy on marsh management or hydrologic restoration for the Corps, there seems to be no other reason to support the time and effort expended in the development of this programmatic document. 7

At a minimum, EPA believes that the FPHMEIS should consider NOD's direct role and responsibility in determining the future direction of hydrologic manipulation projects in coastal Louisiana. In addition to its consideration of alternatives to hydrologic restoration in conserving or restoring coastal wetlands, the FPHMEIS should also consider the alternatives available to the Corps to improve their decision-making abilities and achieve better compliance with permit conditions. 8

Section 102(e) of NEPA states that agencies shall study, develop, and describe appropriate alternatives to recommend courses of actions in any proposal that involves unresolved conflicts concerning alternative uses of available resources. This requirement is independent of the Section 102 requirement that alternatives must be considered in an EIS. Whereas alternatives to be considered in an EIS are alternatives to the proposed action, this independent requirement applies to alternative uses of available resources such as wetlands, fisheries, public access, etc.

Because of growing concerns regarding alternative uses of wetland resources, EPA was called upon to provide the public with its direction on marsh management impacts. The EPA Assistant Administrator for Water has requested the EPA Science Advisory Board (SAB) to review issues related to marsh management. The Corps of Engineers has been an active participant in EPA's development of "guiding principals" for evaluating marsh 10
management projects. We believe that the approaches agreed upon by the interagency committee should be able to provide some potential direction in NOD's evaluation of future marsh management projects. In addition, we are hopeful that the results of the SAB review will be available soon and this information will be provided to the Corps for their consideration in the develop of the FPHMEIS.

DOCUMENT CONTENTS AND FORMAT

Our review of the DPHMEIS found the document to be far lengthy than is necessary for many of the topic discussions and the format cumbersome for reviewing. We suggest that the FPHMEIS consider a format that utilizes distinct sections (rather than 11
sub-sections) with clearly defined topics and summaries with stated conclusions. For example, the document could combine sections on significant resources, indicate why they are significant, identify their controlling factors and potential impacts. This could be summarized in a table format, thereby allowing reviewers to view a side-by-side comparison. This would eliminate some of the redundancy in the document and provide clarity in some of the discussions.

Many of the tables contained in the DPHMEIS were difficult to interpret. The tables should be used to summarized narrative 12
discussions or facilitate the interpretation of information.

PURPOSE AND NEED

Additional discussion on what the PHMEIS is intended to do (i.e., address cumulative impacts, predict future trends, etc.) 13
and how it will be used by the District is needed within this section of the document.

TRENDS ANALYSES

EPA believes that there are obvious and specific trends that are discernible in the DPHMEIS and these should be used to develop some guiding principals for the evaluation of future projects. While marsh management and hydrologic restoration proposals will continue to be evaluated on a case-by-case basis 14
by the Corps and commenting agencies, we believe that there are certain conclusions that can be reached through the DPHMEIS's evaluation of past permitted projects. Instead, the DPHMEIS maintains a distant or neutral position on many relevant issues, thereby avoiding any definitive conclusions about impacts.

EPA believes that additional effort and analysis is needed by the NOD to determine the success and impacts of existing permitted activities. While there are no definitive studies to predict with any great accuracy how or where hydrologic manipulation projects may or may not work, or to provide answers to many outstanding issues, there is sufficient information in the DPHMEIS, the examined literature, and past studies that can 15
be used to state obvious conclusions or trends regarding marsh management. NOD's analysis of permitted projects within each hydrologic basin is a positive step towards identifying some marsh management trends and patterns. However, additional information regarding the viability of implemented projects to accomplish specific management objectives (revegetation, prevent saltwater intrusion, etc.), long-term effects on biological and physical processes in managed areas, and factors to consider in implementing and operating a marsh management are still needed.

As this programmatic document was developed to deal with future, as well as past, permit decisions on marsh management projects and evaluate potential cumulative impacts, a significant concern to EPA is that the DPHMEIS only addresses hydrologic 16
manipulation projects proposed for funding under CWPPRA, not individual projects proposed by applicants for a 404 permit. The DPHMEIS presents a conservative approach in evaluating cumulative impacts. However, in addition to non-CWPPRA proposals, there are other proposed CWPPRA projects (freshwater and sediment diversion, etc.) which may have a pronounced effect upon the existing landscape of coastal Louisiana.

CUMULATIVE IMPACTS

The DPHMEIS does not fully address cumulative impacts. Issues for consideration include: 1) cumulative effects (direct and indirect) on a watershed, including inside and outside the boundaries of managed and unmanaged areas, 2) impacts from non- 17
CWPPRA sponsored projects (non-federal applicants for marsh management), and 3) potential impacts from the CWPPRA sponsored projects such as freshwater and sediment diversions, long-term impacts of managed areas.

The information found in Table 5-20, **Cumulative Impacts** is difficult to interpolate. There appears to be some good information to be gleaned from this table. However, with the present format, it is difficult for reviewers to compare between the effects predicted, with the significant resources that are examined. There is also some information contained in the table that is not presented in the body of the document. 18

In an assessment of cumulative impacts, instead of determining the "significance" of an impact associated with a particular permit activity, the concept of determining "directionality" of the permit impact, with reference to the goals and the existing condition of the landscape unit is important. Cumulative impacts are usually a landscape-level phenomena. Utilizing a landscape focus can conserve valued attributes that may not be manageable at a finer scale. Landscape conservation also conserves the valued functions and biota of smaller subsystems. As the construction of all projects proposed under CWPPRA is unlikely, a more realistic approach would be to use a basin by basin characterization to develop a series of reasonable and foreseeable future scenarios that utilize potential management options based on historical trends. 19

In this same regard, the indirect and secondary impacts associated with the "footprint" of a constructed project are not discussed at any length. Hydrologic isolation caused as a result of a implemented marsh management project is one of the more pronounced indirect impacts that should be evaluated at some length. Cumulative impacts are defined as "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. " (40 CFR Section 1508.7). 20

In addition, there is not a great deal of information on actual effects. Due to the importance of this topic, additional narrative discussion would contribute to a reviewers' understanding of cumulative impacts. 21

SOCIOECONOMICS

Additional topics that should be considered for inclusion under Appendix J, Marsh Management Socioeconomics, are: 1) the costs in implementing a marsh management project (private applicant and CWPPRA sponsored), 2) costs of operating and maintaining a marsh management project, and 3) costs associated with monitoring requirements of permit conditions. This type of information may provide additional insight into the economic considerations a 404 applicant weights in their decision to proposing marsh management over some other type of management 22

option.

An additional consideration that should be examined under the subject of socioeconomics, is the public's right to obtain access to public trust resources such as fisheries, minerals rights, subsistence hunting and fishing, recreation, etc. 23

MANAGEMENT OPTIONS

Marsh management and hydrologic restoration are identified as two separate management options in the DPHMEIS. However, there is no explanation as to how each of the management techniques compare as distinct management alternatives and under what conditions. The information presented in Table 4-1, Comparison of Management Alternatives, is difficult to comprehend and not conducive to a side-by-side comparison. Additional clarification is needed to further define each of the management options as independent restoration techniques and evaluate their potential impacts on significant resources separately. EPA suggests that the FPHMEIS consider an approach that considers the two techniques as wetland management "tools" and the analysis and discussions be treated as a single option (hydrologic management). Otherwise, the FPHMEIS must provide some basis from which hydrologic restoration can be evaluated separately as a distinct wetland management option. We believe that either of these approaches would provide better balance in the document's discussions and organization. 24

MONITORING AND RESTORATION CONSIDERATIONS

The monitoring of marsh management or hydrologic manipulation projects is of significant importance, especially with the uncertainty that surrounds implementation and long-term operation. Since the Corps issues permits for all such actions and has generally included some monitoring and reporting requirements as a condition of permit issuance, it is appropriate to expect that a thorough analysis of this monitoring be included in this programmatic document. 25

However, as indicated in Section 4.8.4.1, and Table 5-20, compliance with reporting and monitoring requirements by permit applicants has been poor. Consistency in monitoring and reporting requirements could provide potential benefits to a permittee as well as reviewing agencies. Parameters to be monitored should be based on the type of information that is necessary to evaluate a project's intended purpose or management objectives and to insure the protection of resources of concern (fisheries, vegetation, waterlevels, etc.) The topic would seem to be ripe for consideration on how future monitoring can and should be improved in the future. This issue, as well as many others associated with marsh management projects, would benefit with the Corp's development of guiding principals or a policy statement for future projects. 26

27

With regard to evaluating and monitoring hydrologic manipulation projects, we suggest that the following series of questions be considered by the New Orleans District in the possible development of "guiding principals" for hydrologic manipulation projects. EPA believes that the Corps ability to provide answers to the questions posed below would provide a sound and technical basis from which to evaluate past and future projects. In addition, these questions would provide some consistency for 404 permit evaluators and reviewers in developing recommendations and permit conditions.

A. PROJECT PLANNING AND DESIGN:

1. Has the problem requiring treatment been clearly defined and understood?

2. Is there consensus on the purpose of the restoration problem?

3. Have the goals and objectives been identified?

4. Has the restoration been planned with adequate scope and expertise?

5. Does the restoration management design have an annual or midcourse correction point?

6. Are performance indicators (i.e. measurable biological, physical, and chemical attributes) directly and appropriately linked to the objectives?

7. Have adequate monitoring, surveillance, management, and maintenance plans developed along with this project, so that monitoring costs and operational details are anticipated, and monitoring results will be available to serve as input in improving restoration techniques used as the project matures?

8. Has the appropriate reference system been selected from which the project can be evaluated based on target values of performance indicators?

9. Has sufficient baseline data been collected over a suitable period of time on the project ecosystem to facilitate before and after treatment comparisons?

10. Have critical project procedures been tested on a small experimental scale in part of the project area to minimize the risk of failure?

11. Has the project been designed to make the restored ecosystem as self-sustaining as possible to minimize maintenance requirements?

27 cont'd

12. Has thought been given to how long the monitoring will have to be continued before the project can be declared effective?

13. Have risk and uncertainty been adequately considered in project planning?

B. DURING RESTORATION:

1. Based on the monitoring results are the anticipated intermediate objectives being achieved? If not, are appropriate steps being taken to correct this problem(s)?

2. Do the objectives, or performance indicators need to be modified? If so, what changes may be required in the monitoring program?

3. Is the monitoring program adequate?

C. POST RESTORATION:

1. To what extent were project goals and objectives achieved?

2. How similar in structural and function is the restored ecosystem to the target system?

3. To what extent is the restored ecosystem self-sustaining, and what are the maintenance requirements?

4. If all natural ecosystem functions were not restored, have the critical ecosystem functions been restored?

5. If all natural components of the ecosystem were not restored, have critical components been restored?

6. How long did the project take?

7. What lessons have been learned from this effort?

8. Have those lessons been shared with interested parties to maximize the potential for technology transfer?

9. What was the final cost, in net present value terms, of the restoration project?

10. What were the ecological, economic, and social benefits realized by the project?

11. How cost effective was the project?

12. Would another approach to restoration have produced

desirable results at lower costs?

ADDITIONAL COMMENTS

PHMEIS, Page 3-2, top paragraph, last sentence. This statement concerning previously permitted marsh management projects that could be characterized as hydrologic restoration requires further explanation. The factors or management goals that distinguish marsh management from hydrologic restoration should be identified. 28

In Section 3.3.1.1.3, additional information should be added in response to the statement that marsh-dependent resources are perceived as proprietary by landowners. Louisiana law has asserted state ownership of wild birds, quadrupeds, fish, other aquatic life and oysters since 1926. 29

Section 4.6.4.1. The descriptions of Basins 1-4 in the Delta, do not indicate what are the perceived or known causes of marsh loss are in these basins. 30

On PHMEIS Page 4-83, the discussion in the second paragraph pertaining to weather patterns and sediment transport is unsubstantiated and lacks clarity. This statement should either be referenced or else be restated to clarify its meaning. 31

PHMEIS Page 4-84, the discussion in the second paragraph pertaining to weather patterns and sediment transport should be simplified. The reference in the last sentence to "assumptions" should be clarified. 32

PHMEIS Page 4-86, third paragraph. This seems to be only place in the document that the effects of waterlogging are discussed with respect to marsh loss. The discussion is very brief and due to the implications of marsh management activities on this effect, additional information and discussion would seem to be justified for this topic. 33

PHMEIS Page 4-95, third paragraph, second sentence. The use of the word "compromise" does not seem appropriate in this statement. Perhaps, "equalize" would be more appropriate. 34

In Table 4.1, much of the information presented here, should be expanded upon and considered for presentation also in a narrative format. There is good information presented here, but the format makes it difficult to discern comparisons between the two management options. 35

PHMEIS Page 5-54, third paragraph, last sentence. The statement made for Basins 5 and 9, that "a possible consequence would be to further disrupt the hydrology of the remaining unmanaged marsh", is of great significance. It is cause and effect relationships suggested in statements like this that are 36

necessary in any discussions of cumulative impacts.

Work on sediment mobilization in coastal marshes conducted by Denise Reed, Nan Walker and others has been presented at a number of symposium and should be included in the FPHMEIS. 37

S.2. Cooperating State Agency

S.2. Louisiana Department of Natural Resources, Coastal Restoration Division (LaCRD)

No comments received.

Fax Transmittal Memo 7672

To BOB Bosenberg
Company COE - Planning
Location N.O, LA
Fax # 504-862-2572
Telephone #
Comments

No. of Pages
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Time
From D. Clark
Company La. DNR
Location BR, LA
Dept. Charge
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Telephone # 342-6690
Original Disposition: Destroy Return Call for pickup

State of Louisiana

EDWIN W. EDWARDS
GOVERNOR

JACK McCLANAHAN
SECRETARY

DEPARTMENT OF NATURAL RESOURCES

January 3, 1996

U. S. Army Corps of Engineers
ATTN: Mr. Robert Bosenberg
New Orleans District
CELMN-PD-RS
P. O. Box 60267
New Orleans, LA 70160-0267

Re: Request for a Time Extension for DNR Technical Comments for the U. S. Army Corps of Engineers' Final Programmatic Hydrologic Manipulation Environmental Impact Statement (PHMEIS).

Dear Mr. Bosenberg:

I have attached a copy of the DNR Permit Processing Narrative sent to you by Dr. Terry Howey of the DNR Coastal Management Division on December 28, 1995. This constitutes the first installment of DNR's comments on the PHMEIS as a cooperating agency.

We request a time extension on the remaining technical comments until January 15, 1996. We are making this request at this time because this is our first day back at work from the New Year's holidays. Our new governor, Governor Foster, and the new administration officialy takes office on January 8, 1996 with the Inauguration. We would like to request a time extension in order for the new governor's administration within DNR to review our comments.

Thank you for your consideration in this request.

Sincerely,

Darryl Clark

Darryl Clark
DNR Cooperating Agency Representative

COASTAL RESTORATION DIVISION
P.O. Box 94396 · Baton Rouge, Louisiana 70804-9396 · Telephone (504) 342-7308 · Fax (504) 342-9417

State of Louisiana

EDWIN W. EDWARDS
GOVERNOR

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SECRETARY

DEPARTMENT OF NATURAL RESOURCES

December 28, 1995

U.S. Army Corps of Engineers, New Orleans District
ATTN: Mr. Robert Bosenberg
CELMN-PD-RS
P.O. Box 60267
New Orleans, LA 70160-0267

RE: Louisiana Department of Natural Resources
Coastal Management Division's
Marsh Management, Permit Processing Narrative
for inclusion in
U.S. Army Corps of Engineers'
Final Programmatic Hydrologic Manipulation Environmental
Impact Statement (PHMEIS)

Please reference your October 19, 1995 Notice of Availability of the Draft Programmatic Hydrologic Manipulation Environmental Impact Statement, and Appendix E of the above referenced document, requesting a written description of Coastal Management Division's (CMD) marsh management permit review process for inclusion in the Final Programmatic Hydrologic Manipulation Environmental Impact Statement. The following discussion provides the requested information.

The Louisiana State and Local Coastal Resources Management Act (SLCRMA) was passed, in response to the Federal Coastal Zone Management Act, in 1978 to protect, develop, restore and enhance the resources of the state's coastal zone. Marsh management plans are a regulated activity under SCLRMA. Section 214.22 of these revised statutes declares it is the public policy of the state to support and encourage multiple use of coastal resources consistent with the maintenance and enhancement of renewable resource management and productivity, the need to provide for adequate economic growth and development and the minimization of adverse effects of one resource use upon another without imposing any undue restriction on any user. It is also Louisiana's public policy to employ procedures and practices that resolve conflicts among competing uses within the Louisiana Coastal Zone.

With this in mind, Coastal Management Divisions's responsibility is to achieve the proper balance between coastal resource use, and the conservation, protection and enhancement of wetlands and other coastal resources. Our mandate is to balance the impacts and benefits of proposed coastal resource uses, and

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resolve conflicts between competing uses, for the overall well-being of those resources which are the property of the citizens of Louisiana. Toward this goal, one of CMD's chief objectives in the review of individual marsh management plans is the resolution or attainment of a compromise between the often competing mandates or concerns of various Federal and State resource agencies, land owners and the general public.

CMD has two sections responsible for the review of marsh management plans. The review of marsh management plans proposed by a Federal agency, or proposed on Federally owned or controlled property, is carried out by the Consistency Section of the Interagency Affairs Branch; likewise, the review of marsh management plans proposed by private citizens, or private companies, or proposed on privately owned property, is carried out by the Permits Section of the Permits and Mitigation Branch.

Marsh management plans proposed by Federal agencies are Direct Federal Actions and are processed as such by the Consistency Section. National Oceanic and Atmospheric Administration (NOAA) regulations at 15 CFR Section 930.30-930.44 require that the federal agency submit to the state program a Consistency Determination and supporting information at the earliest possible time in the planning of the activity. This Determination is made by the federal agency after reviewing the proposed activity in light of the applicable requirements of the state program.

In order to be considered complete, Consistency Determinations generally must include a vicinity map, and a detailed description and plats of the proposed activities, including any dredging or filling (indicating locations, volume of material, disposal sites, etc.), structures or facilities, and means of access. If available, a copy of National Environmental Policy Act (NEPA) documentation (e.g. Environmental Assessments or Environmental Impact Statements) is required. If the U. S. Army Corps of Engineers will require a Section 10/404 permit, a copy of the permit application is also required for the Consistency Determination. Finally, pursuant to 15 CFR Section 930.39, the agency must certify that the proposed work is consistent to the maximum extent practicable with the State of Louisiana's Coastal Management Program.

Department of Natural Resources (DNR) decisions regarding Direct Federal Actions are due within 45 days of receipt of the Consistency Decisions. NOAA regulations provide the state a 15-day extension to that review period when the state notifies the federal agency proposing the project that such an extension is necessary. All projects for which Consistency Determinations are requested undergo a minimum two week public notice period.

If the proposed marsh management plan is to be located on Federally owned or controlled property, but is not to be implemented by a Federal agency, the plan is processed as a Federal License or Permit. All of the information requirements are the same as for Direct Federal Actions. However, the applicant must

certify that the proposed work is consistent with the State of Louisiana's Coastal Management Program. Department of Natural Resources (DNR) decisions regarding Federal License or Permits are due within three months of receipt of the Consistency Determination. NOAA regulations provide the state an additional three month extension to that review period when the state notifies the applicant proposing the project that such an extension is necessary. These time frames assume that all necessary information concerning the proposed project have been made available for review.

If the proposed marsh management plan is to be conducted by private individuals or companies, and proposed on privately owned property, the review of the marsh management plan is carried out by the Permits Section of the Permits and Mitigation Branch. Applying for a Coastal Use Permit is not difficult but it does require attention to detail. If the information or drawings provided are inadequate, the permitting process will be delayed. If the application is not considered complete, the applicant will be contacted by the Joint Public Notice Coordinator and instructed as to what information is needed. Coastal Use Permit Application Information Packets can be obtained from CMD; this packet contains detailed information and instructions.

Once the application is determined to be complete, the application package is assigned to a permit analyst. A public notice is usually issued; this requires a thirty day minimum public comment period. The analyst starts coordinating with other state and Federal agencies to determine the merits of the proposed plan and what changes, if any are needed to satisfy agency guidelines and/or mandates; there is usually an interagency field investigation. Once a consensus is reached, the permit is issued.

Whether processed as a Consistency Determination or a Coastal Use Permit, the plan is checked for compliance with the following coastal use guidelines which are part of the enforceable policies of the Louisiana Coastal Resources Program:

Guideline 1.6 Information regarding the following general factors shall be utilized in evaluating whether the proposed use is in compliance with the guidelines.

a) type, nature and location of use

b) elevation, soil and water conditions and flood and storm hazard characteristics of site.

c) techniques and materials used in construction, operation and maintenance of use.

d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity and salinity; and impacts on them.

e) availability of feasible alternative sites or methods for implementing the use.

f) designation of the area for certain uses as part of a local program.

g) economic need for use and extent of impacts of use on economy of locality.

h) extent of resulting public and private benefits.

i) extent of coastal water dependency of the use.

j) existence of necessary infrastructure to support the use and public costs resulting from use.

k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.

l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.

m) the extent to which regional, state and national interests are served including the national interest in resources and the siting of facilities in the coastal zones as identified in the coastal resources program.

n) proximity to, and extent of impacts on, special areas, particular areas, or other areas of particular concern of the state program or local programs.

o) likelihood of, and extent of impacts of, resulting secondary impacts and cumulative impacts.

p) proximity to and extent of impacts on public lands or works, or historic, recreational or cultural resources.

q) extent of impacts on navigation, fishing, public access, and recreational opportunities.

r) extent of compatibility with natural and cultural setting.

s) extent of long term benefits or adverse impacts.

Guideline 1.7 It is the policy of the coastal resources program to avoid the following adverse impacts. To this end, all uses and activities shall be planned, sited, designed, constructed, operated

and maintained to avoid to the maximum extent practicable significant:

a) reductions in the natural supply of sediment and nutrients to the coastal system by alterations of freshwater flow.

b) adverse economic impacts on the locality of the use and affected governmental bodies.

c) detrimental discharges of inorganic nutrient compounds into coastal waters.

d) alterations in the natural concentration of oxygen in coastal waters.

e) destruction or adverse alterations of streams, wetland, tidal passes, inshore waters and water bottoms, beaches, dunes, barrier islands, and other natural biologically valuable areas or protective coastal features.

f) adverse disruption of existing social patterns.

g) alterations of the natural temperature regime of coastal waters.

h) detrimental changes in existing salinity regimes.

i) detrimental changes in littoral and sediment transport processes.

j) adverse effects of cumulative impacts.

k) detrimental discharges of suspended solids into coastal waters, including turbidity resulting from dredging.

l) reductions or blockage of water flow or natural circulation patterns within or into an estuarine system or a wetland forest.

m) discharges of pathogens or toxic substances into coastal waters.

n) adverse alteration or destruction of archaeological, historical or other cultural resources.

o) fostering of detrimental secondary impacts in undisturbed or biologically highly productive wetland areas.

p) adverse alteration or destruction of unique or valuable habitats, critical habitat for endangered species, important wildlife or fishery breeding or nursery areas, designated wildlife management or sanctuary areas, or forest lands.

q) adverse alteration or destruction of public parks, shoreline access points, public works, designated recreation areas, scenic rivers, or other areas of public use and concern.

r) adverse disruptions of coastal wildlife and fishery migratory patterns.

s) land loss, erosion and subsidence.

t) increases in the potential for flood, hurricane or other storm damage, or increases in the likelihood that damage will occur from such hazards.

u) reductions in the long term biological productivity of the coastal ecosystem.

In addition to the above general use guidelines, the following specific guidelines for hydrologic and sediment transport modifications apply:

Guideline 7.1 The controlled diversion of sediment-laden waters to initiate new cycles of marsh building and sediment nourishment shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the outfall area. Such diversions shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Guideline 7.2 Sediment deposition systems may be used to offset land loss, to create or restore wetland areas or enhance building characteristics of a development site. Such systems shall only be utilized as part of an approved plan. Sediment from these systems shall only be discharged in the area that the proposed use is to be accomplished.

Guideline 7.3 Undesirable deposition of sediments in sensitive habitat or navigation areas shall be avoided through the use of the best preventive techniques.

Guideline 7.4 The diversion of freshwater through siphons and controlled conduits and channels, and overland flow to offset saltwater intrusion and to introduce nutrients into wetlands shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the outfall area. Such diversions

shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Guideline 7.5 Water or marsh management plans shall result in an overall benefit to the productivity of the area.

Guideline 7.6 Water control structures shall be assessed separately based on their individual merits and impacts and in relation to their overall water or marsh management plan of which they are a part.

Guideline 7.7 Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds," permit tidal exchange in tidal areas, and minimize obstruction of the migration of aquatic organisms.

Guideline 7.8 Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

Guideline 7.9 Withdrawal of surface and ground water shall not result in saltwater intrusion or land subsidence to the maximum extent practicable.

Coastal Management encourages an applicant for an individual marsh management permit or consistency to contact our office and arrange a pre-application meeting to make the process as efficient as possible for obtaining an individual Coastal Use Permit or Consistency. For further information please contact Mr. Jeff Harris, Consistency Coordinator, or Mr. Rocky Hinds, Permits and Mitigation Program Manager at 1-800-267-4019.

Sincerely,

Terry W. Howey,
Administrator

TWH/GD/jt

S.3. Response to comments received from the general public.

S.3.1. Dr. Cahoon

1. Agree, see Chapter 2.0., especially Section 2.3.

2. Noted.

3. Citation corrected.

4. Table 4 eliminated.

Rec'd (ELMN-PD-RS) 1/2/96 RNB

December 21, 1995

Donald R. Cahoon
301 Broadmoor Blvd.
Lafayette, LA 70503

Mr. Robert Bosenberg
U. S. Army Corps of Engineers,
New Orleans District
P. O. Box 60267
New Orleans, Louisiana 70160-0267

RE: Comments on the Draft Programmatic Hydrologic Manipulation Environmental Impact Statement and Appendixes

Dear Mr. Bosenberg:

I submit for your consideration comments on the referenced report. I present both general and specific comments.

General Comments Definitions of marsh management, including active and passive, and hyrdologic restoration should be presented in the beginning. In addition, an executive summary should be presented in the very beginning to summarize the overall findings of this review. In this way, the key concepts, terms, and findings are presented up front to help focus the reader on the important issues. 1

Specific Comments

Literature Review. I have some comments on literature citations which could be included. I realize many of these may have been published just as you were completing the draft report, but these citations should be considered for inclusion in the final report. I have included copies of most of these references.

1. The MMS report on the causes of wetland loss in Louisina edited by Turner and Cahoon (1987) provides an excellent overview of wetland loss and the mechanisms driving the loss. 2

2. White, W. A. and T. A. Tremblay. 1995. Submergence of wetlands as a result of human-induced subsidence and faulting along the upper Texas Gulf Coast. Journal of Coastal Research 11: 788-807.

This paper reports wetland loss caused by subsurface fluid withdrawal and associated geologic faulting.

3. Roberts, H. H. (editor) 1994. Critical Physical Processes of Wetland Loss. USGS Open File Report. 500 pp.

This report summarizes the findings of a 6-year field research effort conducted by scientists at LSU on the physical processes driving wetland loss. I particularly recommend the chapter by Day et al. entitled "Physical Processes of Marsh Deteriориation" (Chapter 5).

2 cont'd.

4. Cahoon, D. R., Reed, D. J., and Day, Jr., J. W. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. Marine Geology 128: 1-9.

This paper quantitatively demonstrates the relationship between accretion and elevation change and underscores the necessity for calculating "elevation deficits" rather than "accretion deficits" when determining the potential for marsh submergence and loss.

5. I recommend that you review the special issue of the Journal of Coastal Research on Hurricane Andrew (Special Issue 21, 1995). I have enclosed reprints of papers by Cahoon et al. and Guntenspergen et al. that document the importance of major storms in mobilizing and depositing large quantities of sediment in coastal marshes.

On page 4-38, you cite a reference by Day (1995) but this citation is not listed in the references. I am curious as to what reference this is. 3

Tables. I have some specific comments which I believe will make Table 4 clearer and easier to understand. I recommend that the table take the following format:

TABLE 4-1. Comparison of Management Alternatives: Marsh Management and Hydrologic Restoration.

Resource: Emergent Vegetation on Uneroded Native Soil (See Section 4.9.2 in text)

Management Concern: Of progressively greater interest to managers intent upon forestalling marsh loss, of increasing general interest in role related to forestalling marsh loss

Regulatory Concern: Evaluated by CORPS and some agencies during project comment period and review; some attributes are subject to monitoring 4

	Management Alternative	
Attibutes	Marsh Management	Hydrologic Restoration

A similar style of design could be considered for Table 5 as well.

Thank you for the opportunity to comment on this report.

Sincerely,

Donald R Cahoon

Donald R. Cahoon, PhD

S.3.2. Mr. Daryl Clark

1. Comments noted.

Rec'd 11/29/95
Public Hearing

Darryl R. Clark
118 St. James Dr.
Lafayette, La. 70506
318-981-2298

November 29, 1995

Mr. Robert Bosenberg
U. S. Army Corps of Engineers
New Orleans District
CELMN-PD-RS
P. O. Box 60267
New Orleans, Louisiana 70160-0267

Re: Personal Comments Concerning the Draft Programmatic Hydrologic Manipulation Environmental Impact Statement (PHMEIS).

Dear Mr. Bosenberg;

I have reviewed the above referenced PHMEIS and offer the following preliminary comments for the Public Hearing to be held on November 29, 1995. These comments are to be considered my own, as a technical person working in the field, and do not necessarily represent the current policies of the state of Louisiana nor the La. Department of Natural Resources. I have worked as a biologist in the Louisiana coastal zone in the areas of marsh management and hydrologic restoration regulation and restoration for the past 15 years.

I want to thank you and your colleagues at the Corps of Engineers (COE) New Orleans District (NOD) for your efforts in producing this document that many people and agencies have been long awaiting. The work spent by your office; (1.) in reviewing the marsh management and hydrologic restoration scientific literature, (2.) in analyzing the COE Marsh Management and Hydrologic Restoration permit data from 1975 to 1995 in addition to the CWPPRA project data analysis, and (3.) finally in writing the PHMEIS, which has culminated in tonight's meeting, should be applauded. I feel that the document is well on its way towards the production of a final EIS. I hope that with the final EIS, we can put this Programmatic EIS issue to rest so that we can continue with the state's coastal restoration process with these restoration techniques remaining in the "restoration toolbox."

I support the following Marsh Management and Hydrologic Restoration statement of policy;

"... Wetland Management and Hydrologic Restoration should be encouraged in those instances

when it can help re-establish historical or maintain current salinity regimes within a hydrologic basin context, and/or contribute to a basin's overall sustainable biological productivity and biodiversity." (Good et al., 1993).

I support the position that "modern" hydrologic restoration and wetland management techniques, implemented properly, can be used in coastal Louisiana to retard wetland loss, and in come cases, restore or re-create marsh. These restoration projects must be carried out using modern management techniques, under the supervision or regulatory review of the state and federal wetland regulatory agencies.

I support the DNR Coastal Resources Program, currently administered by the Coastal Management Division, that currently operates under a number of Coastal Use Guidelines which pertain to Marsh Management and Hydrologic Restoration. State coastal use permit applications, for these activities, are reviewed for consistency with the Coastal Resources Program by applying the appropriate guidelines to the activity. Some of these guidelines, which pertain to marsh management and hydrologic restoration, are paraphrased below;

1. Impoundment levees must be part of an approved marsh management plan,

2. Management plans shall result in an overall benefit to the productivity of an area,

3. Weirs and water control structures should be built using the best practical techniques to permit tidal exchange and minimize blockage to fisheries organisms access,

4. Impoundments which prevent normal tidal exchange shall not be constructed in brackish and saline areas.

I also support the proposed modifications to these coastal use guidelines which further define and encourage modern management techniques.

The state's Wetland Conservation and Restoration Authority is specifically mandated to consider privately funded management projects as restoration and to include marsh or wetland management in its comprehensive state coastal wetlands policy [La. R. S. 49:213.4 (1)].

I am in agreement with the final conclusions addressed in Section 5.4 (pp 5-94 and 5-95) of the PHMEIS. Although there has probably been more literature and data gathering on marsh management as a restoration tool than most other restoration methods, there are still not enough definitive studies to predict with accuracy when marsh management may work or not work in every situation in the Louisiana coastal zone. I agree that marsh management and hydrologic restoration can be effective restoration tools to be used in coastal restoration efforts in many cases with minimal adverse effects to fisheries access or productivity or to other living resources. However, if management and hydrologic restoration are not done properly, they may be ineffective at best and in the worse case, may be both ineffective and cause adverse impacts to

fisheries, the marsh, or both.

I agree that the COE should continue to receive marsh management and hydrologic restoration project permit applications, and continue to review those applications and to issue or deny permits, in a timely manner. This PHMEIS should assist both regulators and permit applicants in reviewing and developing acceptable management and hydrologic restoration projects in the future. These projects will continue to go through a rigorous permit and National Environmental Policy Act (NEPA) review process prior to the implementation of either private or public management or hydrologic restoration projects in the future.

I reaffirm the above Marsh Management and Hydrologic Restoration general policy and support the Corps of Engineers NOD's conclusions outlined in the draft Programmatic Hydrologic Manipulation Environmental Impact Statement (PHMEIS). I appreciate the COE's efforts in the completion of this draft PHMEIS.

Sincerely,

Darryl Clark
Biologist

DRC

drc:mshman.eis:11/29/95

S.3.3. Dr. Herke

1. - 2. Noted, the entire document, but especially Chapter 4 and 5 were reorganized and rewritten in response to this general criticism.

3. Noted, no action required.

4.1. Your perception is noted, however, please see Section 5.4.5.3., 5.5.4. and 5.8.

4.2. Rewritten, see Section 5.6.

4.3. Generally disagree, see 4.1. and Sections 4.3.4. and 5.8.

5. Noted, generally disagree, for example see Sections 4.3.4., 4.3.5.2., 5.5.2.3. and 5.6.2., 5.6.4., 5.6.7.

6. The F-PHMEIS contains more information from Cahoon and Groat (1990), the MMS Study, than did the D-PHMEIS. Preparation of the F-PHMEIS has objectively and independently resulted in the inclusion of language that speaks to a potential policy issue raised about the application of MM (Boesch et al. 1994) as you noted. For example, please see Sections 4.3.4., 5.4.1.

7. Noted, see 1. and 2. Also, see Sections 4.3.5.2., 5.5.2. and 5.8.

8. - 11. Noted, Section 5.6.2. is programmatically reflective of your informal estimate and general concern. See also entire Section 5.6. and Section 5.8.

12. Noted, agree, see Chapter 2.0.

13. Corrected, see Section 4.3.5.2.3.

14. Noted.

15. Noted, see 13.

16. Noted, corrected, see Section 4.3.5.2.3.

17. Noted, rewritten, see Section 5.6.13.

18. Noted, see Section 5.1.1.3., Tables C-1. - C-8. of Appendix C, and corresponding narratives at Section 5.1.1.5.

19. See Section 5.8.

Rec'd CELMN-PD-RS
1/2/96
RHB

555 Staring Lane
Baton Rouge, LA 70810-2602
27 December 1995

U.S. Army Corps of Engineers, New Orleans District
ATTN: Mr. Robert Bosenberg
CELMN-PD-RS
P.O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Bosenberg:

My comments on the Draft Programmatic Hydrological Manipulation Environmental Impact Statement (PHMEIS) and Appendixes follow.

I realize that due to circumstances over which you had no control, the draft was almost a decade in the making. This apparently led to the decision to send it out for review without adequate proofreading rather than cause further delay. Nevertheless, that decision resulted in the inclusion of a number of nonsense "sentences" and ambiguous statements subject to misinterpretation. (For example, PHMEIS-5-86 contains a statement, which seems to refer to fish, crabs and shrimp, that marsh management "...probably does have the intended management effects on the targeted components...." If it does refer to fish, crabs and shrimp it is a false statement. Or does it refer to wildlife?) 1
Thus, reviewers may often fail to disagree with points in the draft because they misinterpret what it says. Also, the repetitive statements and redundant nesting of information (e.g. permit areas within basins within coast) does not help the reader's comprehension and increases the difficulty of making informed 2
comment. For these reasons, coupled with the sheer bulk of the draft, you should not interpret my failure to comment on certain points as meaning that I agree with them. 3

At numerous places the PHMEIS states that there is inadequate documentation that marsh management in the long term is generally effective in stopping or reversing erosion (e.g., Table 5-20, pages 5-57, 5-58, 5-60, 5-61, 5-64 & 5-65) and that predicting its impacts and effects is largely a theoretical exercise (e.g., Table 5-20, pages 5-65 & 5-73). Even so, I find the tenor of the text is that marsh management works; and the socioeconomic appendix in particular assumes that marsh management slows marsh loss. 4.1
In general, it seems that the PHMEIS gives at least as much, if not more, credence to anecdotal evidence as to controlled scientific studies. And there seems to be little use or mention of the abundant literature that shows stress is caused in emergent vegetation by waterlogging. 4.2

There is considerable scientific literature on the detrimental effects of marsh management on estuarine-dependent (marine-transient) fisheries in Louisiana, South Carolina, and Florida. I feel the PHMEIS covers this inadequately. In particular, no 5

mention is made in the text of Rogers et al. (1994). That paper made 24 comparisons of managed areas to control or lesser managed areas, in relation to the standing stock or emigration, of 30 marine-transient species. It included 28 comparisons from Louisiana and one each from South Carolina and Florida. Overall trends for both marine-transient standing stock and emigration comparisons were significantly (P<0.01) more negative than positive.

The New Orleans District Corps of Engineers (NOD) agreed in 1987 that the Minerals Management Service (MMS) funded study of marsh management would be a good base from which to write the EIS. NOD then deferred writing the EIS until the MMS study was completed. However, it seems NOD then made little use of the findings of the MMS study. In addition, it totally ignored the recommendation of a scientific panel (Boesch et al. 1994, p. 6 & 82) "...that the use of marsh management be reevaluated and the practice discouraged unless techniques are developed that assure long-term vegetative recovery within impounded areas." 6

The PHMEIS is to include an evaluation of potential cumulative impacts. The text does this to some extent for the possibility of some projects affecting other projects (e.g., see page 5-53). However, the potential cumulative effects on fish, crabs and shrimp are seemingly ignored except in Table 5-20. Thus, they are so buried in the reams of repetitive detail that the reader may overlook them. 7

The socioeconomic appendix, section 3.1.1.1, states that the commercial fishing industry creates 90,000 jobs and has an economic impact of $1.5 billion. Some years ago, as an academic exercise, Barton Rogers and I attempted to estimate the dockside dollar loss in fishery landings because of the area then under marsh management. We did this using the assumption that the fishery production reductions found in Herke et al.(1987a) represented an average loss for all the acreage under marsh management. This seemed a conservative assumption, considering that our study area was 15 miles from the Gulf and the weir on the semi-impounded area had a crest 12 inches below average local marsh surface level, rather than the typical 6 inches. Dockside prices at the time of the estimate, by species, were used. We obtained an estimate of about $35,000,000 lost dockside <u>per year</u>. More acreage has come under management since then, which would tend to raise a current estimate; forms of management which may be less detrimental to fisheries production are gaining acceptance, which would lower a current estimate; and inflation has occurred, which would raise a current estimate. I make no current estimate, but the <u>annual</u> loss in dockside value could be much greater now. Moreover, dockside losses measure only a portion of the total commercial impact on the commercial fishery. 8

Not included in the above estimates are losses to the recreational industry and angler. Louisiana currently has approximately 300,000 licensed saltwater anglers. These create a 9

huge economic impact that will be dampened by reduced fishery production caused by marsh management.

The cumulative biological and socioeconomic impacts of marsh
management on the commercial and recreational fishing industries 10
could be catastrophic; this should be emphasized in the text.
Moreover, since Louisiana contains the major marine-transient
nursery for the entire northern Gulf of Mexico, the potential 11
impacts are regional rather than local.

The PHMEIS draft assumes that hydrologic restoration is less
likely to have a deleterious effect on fish, shrimp and crabs than
is marsh management. I agree with this as a general conclusion so
long as it mimics the original hydrology of the area where it is 12
practiced. Unfortunately, there is so much intergradation between
this practice and marsh management that its effects do have to be
inferred on a case by case basis.

Now for comments of a less general nature.

The statement on page DEIS-4-94 "Perry (1981) and Perry and
Joanen (1986) report finding increased shrimp biomass but generally
reduced numbers of individuals similar to the response reported by
Herke in several of his studies" is false on two counts. Their
studies did <u>not</u> report reduced numbers or increased biomass, and
could not have since they took samples <u>only</u> in a semi-impounded
area. I have reported decreased numbers and increased <u>size</u> of
shrimp in semi-impounded areas in several studies that compared
those areas to nearby unimpounded areas. The only study in which 13
I recall taking increased biomass of shrimp from a semi-impounded
area compared to a paired unimpounded area was in Herke (1971). In
that case it was probably because the mesh size of the gear was too
large to efficiently catch the smaller shrimp; since the more
numerous small shrimp tend to stay in the unimpounded areas for a
shorter period than the shrimp in semi-impounded area, most of them
probably departed the unimpounded area before they were large
enough to be caught by the trawl mesh.

Biomass measurements based on a repetitive series of trawl
samples are subject to a number of biases. In our trapping study
(Herke et al. 1992) we took <u>all</u> organisms exiting two essentially
identical ponds over a two-year period. We took 1,697 kg of brown
shrimp from the unweired pond versus 812 kg from the weired pond.
White shrimp catch was 1,515 kg from the unweired pond and 429 kg
from the weired pond. Of the approximately 30 more numerous
species listed in Table 1 of that publication, about half had an
export reduction in numbers, or weight, or both, of 80% or more in 14
at least one, or both, years.

Estuarine-dependent (marine transient) organisms emigrating
from a semi-impounded area are typically larger than those
emigrating from an adjacent unimpounded area at the same time 15
because their emigration from the semi-impounded area is delayed.
Thus, they have time to grow to a larger size before leaving. They

may also grow somewhat faster because they are less abundant than those in the unimpounded area. But the total biomass of the ones emigrating from the semi-impounded area is typically less than from the unimpounded area. Semi-impoundment results in lower marine transient fisheries productivity. The draft PHMEIS does not adequately point this out.

The draft PHMEIS also indicates that Olmi (1986) found greater numbers and biomass of decapod crustaceans, and that Wenner et al. (1986) did so in general for fish, in a managed semi-impoundment. This is an incorrect interpretation of their studies. In both studies, different sampling methods were used in the semi-impoundment than in the adjacent creek. The studies were qualitative; comparisons of numerical abundance and biomass are 16
invalid. However, Wenner et al. (1986) did note that (1) the semi-impoundments removed shallow-water habitat from the estuarine system, (2) the water-control structures prevented many species leaving the semi-impoundment during adverse environmental conditions such as high or low temperatures or low dissolved oxygen, thereby increasing fish mortality, and (3) transient species that entered the semi-impoundments were prevented from moving down estuary with growth, thus preventing their reproducing, and breaking the important energy link between the marshes and the coastal marine environment.

Section 3.12.2 of the Socioeconomic Appendix makes the undocumented assertion that a moratorium on marsh management 17
projects would weaken the tax base. This statement should either be adequately documented or deleted.

In conclusion:

1. The PHMEIS admits that past compliance with permit conditions has been poor to non-existent and, therefore, the historic data base is uninformative about the success of any project. This 18
situation must be corrected. Monitoring required of the permittee must be limited to that which is reasonable, and of biological significance. These requirements must then be enforced.

2. The cumulative biological impact on fisheries organisms, and concomitant socioeconomic impact on those dependent on the fisheries resources are too great for NOD to simply continue 19
"...its current approach of evaluating each proposal on its own merits." (PHMEIS-5-95).

Sincerely,

William H. Herke

William H. Herke, Ph.D.

American Fisheries Society Certified
Fisheries Scientist, and
Fellow, American Institute of Fishery
Research Biologists

Literature cited above that is not already cited in the Draft PHMEIS:

Boesch, D. F. 1994. Scientific assessment of coastal wetland loss, restoration and management in Louisiana. Journal of Coastal Research, Special Issue No. 20. 103 pages.

Herke, W. H., E. E. Knudsen, P. A. Knudsen, and B. D. Rogers. 1987. Effects of semi-impoundment on fish and crustacean nursery use: evaluation of a "solution." Pages 2562-2576 in Coastal Zone '87. O. T. Magoon, H. Converse, D. Minor, L. T. Tobin, D. Clark, and G. Domurat, editors. American Society of Civil Engineers, 345 East 47th Street, New York.

S.3.4. Dr. Reed

1. - 2. Noted, no action required.

3. Opinion noted.

4. - 5. Noted, the entire document, but especially Chapter 4 and 5 were reorganized and rewritten in response to these general criticisms.

6.1. F-PHMEIS subjected to several internal reviews.

6.2. See 1.

6.3. Optional style of presentation. Opted for narrative presentations.

6.4. See 1.

7. Term eliminated.

8. Noted, for example, see Sections 5.4., 5.5. and 5.8

9. Noted, see Chapter 2.0., especially, Section 2.3.7., as well as Appendix D.

10. Noted, agree, see Sections 5.4. - 5.7.

11. Noted, corrected, see Section 4.3.2.

12. Certainly an option, but See 6.1.

13. Moved to Appendix A, and amended as per other comments received.

14. Noted, see 1., and Section 5.1.

15. Noted, amended, see Section 4.3.2.

16. See 15.

17. Noted, and amended.

18. See 1. and Section 4.3.3.

19. See 1., see also Section 4.3. and 5.4.- 5.7.

20. Noted, see 1.

21. Noted, marsh type differences have been made more prominent in the text.

22\. - 23. Table 4 eliminated, see also 1.

24\. Geographic differences have been made more prominent in the narrative. For example, see Sections 5.1.1.5.1.7., 5.1.1.5.2.3., 5.1.1.5.3.

25\. Rewritten, see Section 5.8.

26\. - 27. Noted, generally agree. See 1., and Sections 5.5.4. and 5.8. are responsive.

28\. Noted, appropriate actions taken.

Written Comments on

Programmatic Hydrologic Manipulation Environmental Impact Statement

Submitted by
Denise J. Reed DJR
LUMCON
8124 Hwy. 56
Chauvin LA 70344

Scope of Comments

I have focused my attention on those aspects of the document dealing with scientific and technical issues, their formulation, presentation and synthesis. I have not concerned myself with details of the CWPPRA projects or the summaries of basin characteristics. I hope to provide comments on detailed technical issues and inconsistencies within the next week or so, as my comments on many of these require me to check sources and literature. I have included several such comments here to illustrate and demonstrate more general points about the EIS. 1

I have no experience writing EIS documents but considerable experience writing technical documents both for scientific and lay audiences. Thus, some of my comments regarding content my be ill-informed regarding EIS procedures. However, I hope you will appreciate that if I have difficulties with the document, those unused to large official documents may also have problems. 2

Preparation of Document

I am disappointed to note that the extensive list of preparers does not include any academic research scientists, government researchers, or private consultants. Given the extensive contributions made, and cited within the document, by these groups to these issues in the last twenty years it seems neglectful to not bring them in to the preparation of the document. Their input at an early stage may have resulted in improved draft product. As usual, the insights and expertise of this group is only allowed into the process during the review stage where their comments almost always seem critical, no matter how constructive. An important high-profile draft document such as this should be the result of collaboration between experienced, knowledgeable and interested parties from many backgrounds. 3

Terminology and Style

General

There are many difficulties involved with the interpretation of technical issues for the public. This has apparently been one of the goals of the EIS - to provide technical information in a readily understandable format. The challenges are to maintain technical accuracy and credibility without the use of extensive narrative, jargon and detail. I do not underestimate the nature of these challenges. However, the EIS appears to meet them in 4

many cases by using a 'chatty' narrative style which 1) makes the document extremely lengthy (intimidatingly so for the lay audience), 2) confuses those issues which are clearly documented and those which are based on little documentation, and 3) often simplifies technical issues to the point of irrelevance and/or confusion. Terms such as 'pretty much' are subject to wide interpretation, provide little information to the reader and can be misleading

The lengthy and compartmentalized nature of the document makes it difficult to follow the purpose of each sub-section. Each third level section (e.g., 4.8.4, or 3.2.1) should have a clearly defined purpose and come to some kind of conclusion or summary, preferably in bullet format. This will aid the development of overall synthesis and conclusions of the document. 5

Recommendations: 1) that the document be professionally edited by a technical editor with experience in providing information to the public, 6.1
2) that a target length be set for the document before this editing occurs which is approx. 50% of current length (xcl. appendices), 6.2
3) that more use be made of short tables and conceptual figures which are incorporated with the text, 6.3
4) that major subsections include some statement of purpose or question, the narrative is then focused on that purpose/objective, and some summary bullet statements/conclusions are provided. 6.4

Specific Points

Page 1-3. The use of the term subjective science is confusing. It is unclear what it means. It should be removed or at least defined in this context. I do not believe it is an accepted term. Its present use undermines the detailed scientific studies which have been presented on marsh management. 7

Recommendation: include narrative to the effect that data is rarely available to quantitatively evaluate all aspects of the project and so some subjective judgment on the part of the applicant and regulator may be required. 8

Page 3-10, para 3.4.3.6 and Page 4-3, para 4.1.5 and Page 4-30, para. 4.6.1. The use of the term 'erosion' is erroneous. Erosion appears to be used to mean land loss in any form. The word is a technical term which implies some kind of physical transport and removal of sediment. According to Webster's the common usage means to wear away. By using this term the EIS implies the mechanisms of marsh loss. While erosion may be important in some areas, it should be distinguished clearly from other forms. The linking of the term 'erosion' with interior marsh break-up and hot-spot formation is particularly misleading. Current thinking on these issues involves decompositional processes (hardly erosion) primarily and imbalance between accumulation and subsidence (not erosion). The Joanen use of the term erosion is very confusing but at least it is qualified as a peculiar form. However, as it is only cited as a pers. comm. why does it merit inclusion when all other individuals interpretations of the word do not. 9

Section 4.6.2.2 seems to be a description of a process commonly referred to as 'tidal scour' This is different from interior marsh deterioration where vegetation dies without any additional stress from flowing water. That distinction needs to be made here and it should be clear that flowing water is not a required component for plant death and marsh deterioration.

Recommendations: (1)Use the term land loss rather than marsh erosion, and rewrite section 4.1.5 to be more technically accurate. Saltwater intrusion is not a concept which is widely documented (as discussed later in the EIS). Use this section to distinguish between shoreline erosion and interior deterioration as forms/types of marsh loss. Do not infer mechanisms at this stage which major amplification of this section.

(2) Be much more technical in the use of the term erosion in section 4.6.1 and 4.6.2. Include other descriptions of marsh loss, including Baumann et al.'s 1984 discussion of marsh submergence (the conceptual diagram from Nyman et al. 1993f would be very useful here). 9 cont'd.

Page 3-7. Para. 3.3.2. Why are biological consequences the ones of focus? Many of the significant resources identified in the document are not biological, and the thrust of the cumulative effects issue is ecological. See also page 4-1, Para 4.0 line 5. 10

Recommendation: This should be changed to ecological or environmental.

Page 4-21. 2nd para. The final sentence in this paragraph appears to refer to the correlation between bulk density and growth of *Spartina alterniflora* (assuming that you mean Pezeshki et al. 1989 - there is no 1988 in the bibliography) which Pezeshki et al. use from DeLaune's work. This is a correlation and **does not and cannot** imply cause and effect. Therefore it cannot illustrate a point that soils **effect** marsh plant distributions, rather it shows that they might be related. This study is also inadequately cited on page 4-85. Pezeshki et al. clearly say that 'data regarding this question are inconclusive to date, and further research is needed'. These aspects of the original paper are lost in the interpretation and the EIS wrongly attributes the conclusions of the study. These are **serious technical flaws** and the writer should not add this level of interpretation without making it quite clear who is doing the interpreting. This type of loose discussion, albeit in the name of writing a document for a non-technical audience, can only perpetuate inaccuracies and misinformation. 11

Recommendation: that a thorough technical review of the document be undertaken, involving both academic and agency members of the scientific research community, to try to ensure that any additional such flaws are found and the narrative amended appropriately. 12

Pages 4-22 to 4-29. This section deals with basic descriptive information on marsh types in Louisiana. This information could be presented much more efficiently in tabular form. 13

Recommendation: that a table be developed with one column for each marsh type and the sub-headings under 4.5 presented as rows with relevant

information presented in list or numerical form. Chabreck's (1972) species list table could also be included.

Section 4.8.6, pages 4-78 to 4-80. This section has no clear objective and fails to come to any conclusion. It follows a detailed description of permits issued by basin and could provide a useful purpose in reviewing whether monitoring data collected as part of these permits has provided insights into the success, or not, of those projects which have been constructed. 14

Recommendation: that this section be rewritten to pose and answer questions such as the following:

How many permitted projects achieved their goals (and by what indicators)?

Is monitoring being conducted and what does it show?

<u>Technical Discussion</u>

Page 4-17. 4th para. The description of the formation of the chenier plain is very wordy and difficult to follow. Several publications by Penland provide concise descriptions in 2-3 sentences with an excellent figure to show reworking and progradation (I can provide/point you to them). 15

Page 4-18. 3rd para. Kuecher's work includes important findings regarding variations in subsidence within basins and subbasins. This deserves an extra sentence at least. 16

4th para. Penland and Ramsey do not really discuss what will happen. The reference should be placed after the first clause of the sentence. Use an IPCC projection as a reference is you want to mention future sea-level rise. 17

Section 4.7, pages 4-36 to 4.43.. This overview section adds little to the document, either in a technical or regulatory manner. All of the technical information is reiterated in the Significant Resources section. The objective of the section is not clear. 18

Recommendation: either a) specifically state the objective for the section and concisely meet that objective, or b) use the section to briefly state the difficulties of collecting documentation to support the discussion of Significant Resources, or c) delete the section altogether.

Section 4.9. This is the section which evaluates the effects and benefits of marsh management on significant resources (my interpretation - the EIS does not tell me). In my mind, this is the critical part of the technical narrative. The EIS states that the narrative profile for each resource is intended to convey 1) why the resource is significant, 2) what controls or influences it, and 3) how it relates to management.

The narrative profile rarely achieves these goals. For instance, 4.9.1 Marsh Soils fails to address the factors which cause variation in soil composition (marsh type?). The discussion/narrative for each resource does not distinguish between responses/influences/controls which vary with marsh type. This is the most fundamental of categories for the description of anything to do with Louisiana marshes. A statement 19

which is quite true about a salt marsh can be quite wrong about a fresh marsh. Lack of distinction and the mixing of information about all marsh types together is an approach which is almost guaranteed to provide a lack of conclusive evidence for systematic process-response mechanisms.

Much of the information included in various categories/resources is repeated. A distinction between those controlling factors (externally forced?) which influence the significant resources, and the significant resources would be useful. A regrouping of the significant resources would also make the narrative more efficient. 20

A restructuring of the narrative to include narrative tables and the distinction between marsh types would be more efficient and make it easier for the reader to identify similarities and differences between study findings. 21

The present Table 4-1 includes much information that is repeated in the narrative but without cross-reference to the narrative. Thus, the literature is said to be conclusive on a point in the table but the supporting references are not identified. The lack of a clear distinction between marsh types is a critical error in this table. 22

Recommendations: (1) Identify controlling factors such as water level, salinity, subsurface geology, climate, geomorphology and describe patterns in their variation between marsh type and between the chenier plain and the delta plain. Also include possible impacts of marsh management on these factors. Use tables wherever possible. Put this section before the discussion of individual significant resources. 23

(2) Categorize the Significant Resources, for example:

- Physical Environment
  - soils
  - ponds/open water
  - suspended sediment/nutrients
- Microorganisms
- Primary Production
  - emergent wetland vegetation
  - submerged aquatic vegetation
  - phytoplankton
- Secondary Production
  - Fish (nekton/ fishes and macrocrustaceans?)
  - Benthos
  - Zooplankton
  - Reptiles (inc. skin bearers)
  - Mammals (inc. furbearers)
  - Birds (inc. waterfowl)
- Threatened and Endangered Species
- Socio-Economics
- etc., etc.

(3) For each resource, under an appropriate subheading (not nec. numbered), provide a brief (one paragraph or up to 5 bullets) about why it is significant.

(4) For each resource, under an appropriate subheading, provide a brief on which of the previously identified controlling factors are important, e.g. salinity for SAVs, and which other resources it interacts with, e.g. ponds, suspended sediments and SAVs. This could be tabulated.

(5) Summarize technical information regarding the impact of management in tabular form, for example (this information is **made up** to give an example- it just illustrates the kind of thing I'd like to see): 23 cont'd.

		Fresh	Intermediate	Brackish	Saline
SAV	*Delta Plain*	Killed off by saltwater during hurricane (refs)		Inc. growth cf. control at Fina (Cahoon and Groat) Used by fishes (Marsh Island)	Not found
	Chenier Plain	Inc. growth found at Rockefeller (Joanen??)	Benefit from drawdown (Paille et al.)	Best at salinity < 15-18 (Joanen and Glasgow)	Not found

The benefit of the table is that it allows comparison between marsh types and between areas. The distinction between areas (delta plain vs. chenier plain) will be useful when discussing the significant resources with regard to the future CWPPRA projects. References should be included so that follow-up can be made but extensive narrative should not be used as well as the table. A separate table should be prepared and included in the text for each resource. 24

Synthesis/Conclusions

The EIS fails to draw any systematic conclusions regarding the impact of hydrologic manipulation and fails to define a single statement applicable to all situations. As a result, the conclusion is that business will proceed as usual by evaluating all permits on a case-by-case basis. This conclusion fails both the Corps and agencies involved in the preparation of the document, and the landowners and agencies seeking permits. 25

A single statement is an entirely inappropriate goal for this document. The diversity of the coastal environment is not infinite. We can successfully agree of differences between marsh type and between the chenier plain and delta plain of coastal Louisiana. The reorganization of the Significant Resources section as suggested here will allow systematic variations in management success to become apparent. The bibliography includes much relevant information which should be used to determine such interim conclusions as: manipulations in fresh marshes will have less impact on estuarine organisms than in brackish or saline marshes, and there are few benefits but many disadvantages to manipulation of hydrology in saline marshes in the delta plain. Such 26

general statements as this should be identified wherever possible and the NOD should be able to stand by them and use them in the permit process. There will be no such conclusions on many issues, and these also should be drawn out.

The EIS states that care should be taken to avoid broad generalizations. I agree. Rather, a more constructive approach is to compartmentalize the problem and find agreement/factual determination where it can be found. 27

Recommendation: provide bullet statements which summarize areas of agreement regarding the impact of hydrologic manipulation on significant resources, and provide these as a basis for the factual determination which each permit requires under 404 (b) (1) (stated on page 2-2).

<u>Minor Wording Changes/Inconsistencies Identified Thus Far</u>

Page 3-5. Para. 3.3.1.1.2 line 3. Change 'provide' to 'allow'.
Page 4-7. Para. 4.2.2.3.1 line 1. Insert 'commercial and/or recreational' before species. Species other than these may be more abundant - it is unclear what you mean by principal. 28
Page 4-9. Para. 4.2.2.3.3. Inlcude species/more details to be consistent with previous two sections.
Page 4-20. 3rd para. Sasser 1979 should be 1977.
Page 4-25. Para 4.5.2.3. Sasser 1995 not in bibliography.
Page 4-107. 2nd para. Final sentence incomplete.

S.3.5. Coalition to Restore Coastal Louisiana (Coalition)

1. Noted, no action required.

2. The F-PHMEIS has been substantially reorganized and rewritten.

2.1. Agree, see the Table of Contents and Chapters 4.0. and 5.0.

2.2. Agree that definitions and concepts should be presented sooner....see Chapter 2.0., especially 2.3.

2.3. See Chapters 2.0. and 3.0.

3. Noted, see 2.

4. Agree, see Section 2.2.2. and Chapter 3.0., especially 3.2.

5. Agree, see Sections 5.4.- 5.7.

6. Agree, note expanded use of citations.

7. The candidate CWPPRA HM projects, by definitions and design, has as their principal goal addressing marsh losses. Some have restoration as a goal others have the suppression , stoppage or reversal of on-going or future losses as their goal. Tables Q-1 through Table Q-6 speak clearly to those points. The differences as well as the similarities between HR and MM projects are clearly set forth in Chapter 2.0.

8. Noted, the focus of the subject EIS was HM, not a rewrite, reanalysis or expansion of the CWPPRA EIS. See Section 2.3., and Chapter 3.0., especially, 3.2.1.

9. Agree, see Sections 2.3.10 and 2.3.13.

10. Noted, see Section 5.8., which is responsive.

11. Noted, see Sections 4.5. and 5.6.

12. Disagree, see Sections 1.1, 4.3., 5.8., and Appendixes K - P.

13. Noted, agree, see Sections 4.3., 5.6, and 5.8. Appendixes K - P.

14. See Section 4.3.

15. Noted, see Chapter 2.0. and Sections 4.3. (especially 4.3.3.) and Appendix B.

16. Noted, generally, agree, see Appendixes C, D and Q, Section 4.4.2.2.3., and 5.4.

17.1. Monitoring discussions have been considerably expanded. See Sections 4.3.3., 4.3.4., 4.3.5., 4.5., 5.1.1.3., 5.1.1.4., 5.1.1.5., 5.3.3., 5.4.5., 5.5.- 5.8. and Appendixes K - P.

17.2. Funds were specifically allocated for NOD economists to characterize the existing socioeconomic setting at a programmatic level. Funding was based upon cost estimates provided by the economists. The economic analysis did not conclude that future impacts could not be predicted, as alleged in the comment. However, the analysis did reveal that much more could be learned. NOD concluded that socioeconomics could be a fertile area of future elective academic inquiry for any entity so included.

18. The comment appears to reflect a misreading of the passage. Appendix D is based upon time sequence aerial photography. Use of Appendix D was liberal. But, use of aerial photography has limitations, which were stipulated explicitly in Appendix D.

19. Passage eliminated, but see Section 5.1.1.5.

20. Rewritten, see Sections 5.4. - 5.8.

21. See 17.1.

22. Generally agree, but, for example, see Section 5.8.

23. Noted, see Section 5.4.1.

24. Noted, generally agree, see Section 4.3.5.1.

25. Noted, addressed by reorganizations, see, for example, Sections 4.3.4., 4.3.5., and 5.1.

26. Noted, addressed by reorganizations.

27. Rewritten, see Section 4.3.4.5.1.

28. Noted, the subject section has been reworked for added clarity. However, the comment has interpreted the cited work correctly, and it was represented in the D-PHMEIS as an unproven theory. And, the last portion of the comment does raise an interesting but extended question.

29. Rewritten, see for example, Section 4.3.4.1.2.

30. Again, the comment would seem to possibly be the result of a

misreading of the passage. The passage included qualifiers and reads "....greater potential to perpetuate....". It is not a statement of fact. Thus, clarification may be required but reconciliation of conflicting passages is not.

31. Corrected.

32. Noted, no action required.

33. Noted, see 4.3.5.1.

34. Noted, see Sections 4.3.5. and 5.5.2.

35. Agree, see 32 and Section 5.8.

36. Rewritten, see Section 5.6.

37. Noted, generally agree, see Section 5.6.10. See also Section 5.3.13.

38. Agree, see Sections 4.3.6. (especially 4.3.6.8.2.) and 5.6. (especially 5.6.8.).

39. Rewritten, see Section 5.3.13.

40. Rewritten, see Section 5.6.14.

41. Rewritten, see Section 5.6.15.

42. Rewritten, see Section 5.6.19.

43. Table 4 was eliminated. Reorganization, restructuring and additional citations are responsive.

44. A wide-ranging comment with a philosophical underpinning hinging on definitions. See Section Chapter, 2.0. for definitions and Sections 5.4. - 5.8. for impacts discussions, as well as Appendix Q.

45. Noted, see Appendix Q.

46. Amended, see Appendix Q.

47. Rewritten, see especially Sections 5.3.1., 5.3.2., and 5.3.3.

48. Noted, rewritten, see Sections 5.3.2.1. thru 5.3.2.3., 5.3.3. and 5.4.thru 5.8.

49. Noted, rewritten see Sections 5.3.1.1. thru 5.3.1.6., as well as 5.4. thru 5.8.

50. Noted, see Chapter 2.0.

51. Noted, Chapters 4 and 5 were reorganized, and extensively rewritten in response to this and general criticism of the draft document.

52. Noted, see Sections 5.1.1.3. (reference monitoring), 5.1.1.5. (analysis of permitted projects, which includes discussions of monitoring), as well as Section 5.4.5.2., and Section 5.8.

53. Noted, see 51.

54. Noted, see 51.

55.1. Reference "minerals", see Sections 5.6.4., 5.6.5., 5.6.8., 5.6.11. and 5.6.21.

55.2. Reference "recreational, see Section 5.6.2.2., 5.6.7., 5.6.11., 5.6.16., and especially 5.6.21.

56. Amended, see Appendix B.

57. Noted, no action required. However, see Sections 5.6.21. and 5.8.

58. Noted, and cited in the F-PHMEIS (eg, 5.1.1.5.3., 5.4.3.).

Coalition to Restore Coastal Louisiana

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December 29, 1995

Mr. Robert Bosenberg
US Army Corps of Engineers - New Orleans District
CELM-PD-RS
New Orleans, Louisiana 70160-0267

Dear Mr. Bosenberg:

We recognize that developing this draft PHMIES has been a challenging multi-year undertaking. The PHMEIS is much needed in light of the diverse opinions about the appropriate application of marsh management. This document, as written, contains many typographical errors and editing errors which we did comment on, and many we were unable to comment on due to time constraints. It is a cumbersome document to read, as there is much repetition and a difficult ordering of topics. We hope our comments, and the other comments you receive, can help improve the readability and clarity of this document. 1

Regarding overall format and structure of the document, we understand that the diversity of topics addressed in the document must be addressed for the PHMEIS to be accepted, however, the topics should be better organized. The following group of suggestions and recommendations addresses the structure and format of the document. 2

- The chapter headings should be reduced and reorganized to follow a stronger, clearer, path. The structure of the document should be a logical progression, ultimately accomplishing the purpose of the PHMEIS - which we assume is to draw conclusions about the cumulative environmental impact of marsh management projects on coastal Louisiana. Several repetitive areas should be reorganized and condensed. For example, information in section 4.5 <u>Louisiana's coastal marsh types and their associated/dependent biological resources</u> should be combined with section 4.9 <u>Significant resources and management</u>. As another example, section 4.9.5 <u>Aquatic vegetation</u>, can be reorganized to contain the <u>Plant</u> species information in section 4.5.1.1; 4.5.2.1; 4.5.3.1, etc. The same would be done with <u>Soil type</u> information, in section 4.5.1.2; 4.5.2.2. etc. Also, sections like 4.2.3.1 <u>Landowner/leaseholder point of view</u>, are repetitive of sections like 4.9.21.11.1 <u>Landowners and limiting public access</u>. In general, The document would be much more readable if there were fewer major headings. All information regarding the same general topic, should be kept together. 2.1

- A statement of purpose and a section on definitions should begin the document. The purpose section must clarify what this document intends to do. An appropriate objective would be to analyze the individual and cumulative impacts of existing marsh management projects, and predict cumulative impacts of future marsh management projects under a given scenario. It 2.2

should be made clear that this document is not a marsh management 'how to' document, and it will not settle disputes about marsh management practice or science. Its purpose should be to synthesize data and science on marsh management impacts to predict what the environmental impact of future management will be.

- Precise, concise definitions must be included up-front. What exactly, for the purposes of this PHMEIS, is marsh management? How, precisely, does hydrologic restoration differ from marsh management, for the purposes of this PHMEIS? These questions are critical. We can discern no consistent difference between the two terms, marsh management and hydrologic restoration, throughout this document. In section 3.1, an attempt to distinguish hydrologic restoration from marsh management is made. This distinction seems useful, and could provide a basis for application throughout the document. In this sense, the term 'hydrologic restoration' should be used solely when the management scheme discussed allows the managed marsh to respond "... in synchrony with the rhythms, dynamics, and chemistry of the surrounding system but in a fashion that mimics a historic, often natural, situation." (Page 3-1) The term 'marsh management' should be used for all projects that involve partially or wholly isolating a system from the rhythms, dynamics, and chemistry of the surrounding system. Additionally, in light of the statement by Chabreck, quoted on page 4-4 of the PHMEIS, 'marsh management' should refer to the manipulation of a marsh and associated waterbodies to enhance marsh vegetation. 'Waterfowl management' or 'marine fisheries management' should refer to the manipulation of a marsh, other elements, and associated waterbodies to enhance waterfowl or marine fisheries, as specified. Multiple-goal management should be identified as such. 2.2, cont'd.

Confusion and inconsistencies exist throughout the document because of inadequate definition. "...NOD views marsh management and hydrologic restoration as legitimate alternatives to each other as well as several other management options (e.g., sediment diversion, freshwater diversion) to control (principally) marsh erosion." This statement by NOD on page 3-3 causes some confusion due to lack of definitions and consistency. It raises the question is 'hydrologic restoration' the synonym for 'marsh management' or should the synonym be 'hydrologic management' (or 'manipulation' as in the title of the PHMEIS)? 'Restoration' implies restoring previously existing conditions or functions. The terms 'management' or 'manipulation' do not imply the restoration goals. Additionally, if marsh management is a "legitimate alternative" to the other management options, this should be fully described in the Alternatives section. Confusion over how hydrologic restoration is different from marsh management is increased by this statement on page 5-53: "The intent of every marsh management project and most of the hydrologic restoration projects appears to be to make the targeted area physically and hydrologically unique from the rest of the unmanaged system." 2.3

- The main body of the document should lay out the pathway and structure that the document will take to achieve its purpose. A logical progression for this might include: 3

(1) A discussion of the significant resources that are present in coastal Louisiana and that may be impacted by marsh management. The economics associated with these resources should be presented here.

(2) A literature review of the "state of the science" on marsh management, and on the responses of the significant resources, to various kinds of management and manipulation.

(3) A discussion of the historical and present marsh management projects that have been implemented. This should be subdivided into pre-404 permit program, and post-404 permit program. To the extent possible, the project's purpose, brief description, and degree of success in meeting its purpose should be discussed

(4) A discussion of the cumulative impacts of the historical and present marsh management projects. The impacts on significant resources should be described.

(5) Development of the future scenario or scenarios that will be used to predict future cumulative impacts. If the scenario assumed in the draft document is the scenario chosen, then an explanation of why chosen and its appropriateness should be given. We disagree that assuming all CWPPRA marsh management projects are implemented should be the driving assumption of the PHMEIS. Certainly not all CWPPRA proposed projects will be constructed. A basin specific assumption should be developed, using assumptions based on average number of projects and average acreage under management in each basin, based on historical trends. CWPPRA proposed marsh management projects should be considered to determine if the basin trend is likely to accelerate upward or downward. 4

Another concern regarding the use of CWPPRA-projects-only as the future scenario is found on page 4-13. Here it suggests that CWPPRA is a forum to "...design and fund plans that reflect the broader social and economic implications of managing marshes (Steller et al)." Actually, as the CWPPRA legislation is currently read by the Task Force agencies, the mandate is perceived to be fairly narrow. That is, to protect, restore, create or enhance vegetated wetlands. Broad social and economic concerns have explicitly been left out of consideration when projecting costs and benefits of CWPPRA projects.

(6) A final section that predicts the cumulative impacts of the future scenario, based on existing impacts from implemented projects and on the scientific literature. 5

Other general comments are as follows:

- The document tends to treat anecdotal evidence and commentary with the same weight and credulity as independent scientific reports. Scientific data from peer-reviewed sources should be weighed heavily, as should all data-driven work and reports. Anecdotal and descriptive work, without some supporting quantitative data should not be accepted on an exactly equal basis, but should be accepted with the qualification that corroborating data should be gathered before such data is relied on for decision-making. 6

- Since this PHMEIS proceeds assuming that future marsh management projects will be CWPPRA projects, is it also assumed that all future marsh management projects will have as their sole purpose the restoration of vegetated wetlands? Wouldn't future marsh management projects with a different purpose, such as waterfowl habitat production, or a mixed purpose, 7

have different impacts than projects under the guise of CWPPRA? This document should carefully consider these questions before promoting a 'future scenario'. 1

- In chapter 3, Alternatives, major restoration projects such as use of siphons and river diversions are not discussed as alternatives. The 'consistency' principles essential to the local, state, and federal restoration efforts must be addressed by listing and describing all alternatives to marsh mangement. There are many proposed CWPPRA projects and state projects, other than marsh management projects, that should be mentioned as 'alternatives.' Additionally, there are studies such as the NOD's own CWPPRA river diversion feasibility study that may have an
impact as an 'alternative.' The existing "no action" section does not indicate what the range of 8
effects of "no action" might be. "No action" on further marsh management does not necessarily imply no action on other restoration techniques. This section should consider future scenarios with continued land loss at approximately the current observed rate of loss; accelerated loss due to possible climate change and accelerated sea level rise; and reduction of land loss rates through successful implementation of other restoration projects using techniques other than marsh management.

The following comments are more specific in nature. We have a number of concerns with specific details in the text of the PHMEIS including typographic and editing errors, as well as concerns over interpretation of statements. However, due to time constraints, we are not able to
address them all. The major comments are as follows: 9

- Section 4.1.5, text attributed to Joanen, personal communication. This seems to be an erroneous or at least highly irregular use of the term 'marsh erosion.' Why is this included? This statement is repeated in section 4.6.1.

- Page 4-11, NOD quotes Chabreck, 1960 and 1994, that "...the perception was that if marsh-dependent species benefitted then surely the marsh in general also was benefitted." NOD states on page 4-4 that "Management actions that generally benefit native emergent and aquatic vegetative species also tend to impart favorable, indirect benefits to many marsh dependent organisms often with fewer overall adverse impacts than if a specific organism is targeted."
These perceptions are merely that, perceptions. They should not form a basis for decision 10
making, unless supported by documented evidence. Actually, certain marsh management actions may have significant adverse effects on specific organisms (Herke 1979, 1992). Also, certain marsh management activities that benefit specific organisms may harm or hinder overall coastal restoration objectives - such as optimizing sediment delivery (Cahoon, 1991). How then does NOD support such generalizations as that on page 4-4?

- Section 4.2.2 Attributes of general social and economic significance, is a key section. The information here should be moved to the Significant Resources section (see discussion of
the document main body above). It should be expanded on, with actual economic figures 11
included where available. Difficult and controversial aspects of social and economic significance should be expanded on. For example, section 4.2.2.2, Mineral Value, states that

private land that has become open water reverts to state ownership. In practice, this fact is clouded by the landowner's right to reclaim land. Yet this section does not explain that, in practice, the state does not press its claim to private lands that have reverted to open water. For landowners, preserving a physical boundary around their property, such as levees or canal and channel banks, more readily preserves their surface and subsurface rights even as the land therein may continue to convert to open water. One perspective of this complex issue not put forward in the PHMEIS is that landowners who request marsh management permits not only receive benefits from the preserved economic use of their land (leases, fees, oil and gas income), but also prevent the state from being able to press an ownership claim if land converts to open water. This prevents the state from receiving the potential income, and preserves the income in private hands. This is offered as an example of the many differing perspectives we are aware of that exist on socioeconomic issues, that are not included in this PHMEIS. 12

This issue, and other complex issues that can be seen from a multitude of perspectives such as public access and liability, should be fully explained. It must be acknowledged that the NOD is not the arbiter of these issues. But the NOD must, under its permit granting obligations, consider and weigh this type of issue. These social and economic concerns are intertwined with the cumulative impacts of marsh management. 13

- What are the "...other economic, social, and legal reasons to manage marshes" that have emerged since the 1980's (section 4.3.3)? What are the "...administratively created disincentives" (Wilkins and Wascom, 1989) referred to in that section? 14

- Section 4.7 <u>An overview of the written record</u>, is apparently intended to be a literature review. The literature review section should be reviewed by a broad team of scientists in their area of expertise. The literature review section in its present state is inadequate. For example, Section 4.6.3 <u>New marsh erosion insights</u>, lacks new information on marsh erosion processes from both Denise Reed and Nan Walker. Information from their recent work, and others working on sediment mobilization issues, can aid in understanding processes that relate to the impacts of marsh management. All literature review information should be available in one "State of the Science" section. The scattered literature review information from throughout the document should be collected here. 15

- The <u>Chenier plain basin summary</u>, section 4.6.4.2.3, explains that some areas of land loss "...more recently (1974 to 1990) are either in the shape of rectangles ... or within the area circumscribed by other man made surface landscape features." And the section states "Areas of marsh loss...between Sabine and Calcasieu Lakes, are notable for their geometric patterns of repeated right angles and long straight margins. These loss areas coincide remarkable well with formerly impounded and managed areas." This finding should be explored further in a section on 'Cumulative impacts' of existing projects. This finding seems to indicate that the impacts of some types of management on some marshes can be demonstrably negative. Is this finding due to outdated techniques, or is it an unavoidable risk of marsh management? This document must 16

attempt to "go the extra mile" and explore the reasons behind management failures as well as successes, for extrapolation to a future scenario.

- Section 4.8.2 states that "The permit data base is a very poor tool with which to infer success of the permitted activity relative to its stipulated purpose. Monitoring reports, typically required as a permit condition, were intended to provide these insights." As stated in several places in the PHMEIS, there was poor compliance with monitoring requirements. The intention of having monitoring reports provide insights was not realized. This lack is notably one reason that the projection of potential cumulative impacts under future conditions in this draft PHMEIS is weak. 17.1 This lack of monitoring reports providing insights also begs for additional analysis of the success and impacts of the existing permitted activities. This could be accomplished by many methods, including the comparison of pre-project and post-project aerial photography, combined with ground-truthing in managed sites and comparable non-managed sites. If time or funding limitations preclude the gathering of data such as this, which is essential to predicting 17.2 future impacts, then the existing inadequate basis for predicting cumulative impacts must be acknowledged in this report. In section 4.8.3 NOD indicates that "...time sequence photography...is merely an index..." and thereby dismisses its use. However, it may be the best 18 index of impacts available, in light of the lack of monitoring data, and should be used.

- The basis for the assumption (page 4-47) that "...by extension, permit issuances can be used to approximate impacts and effects" must be clarified. Does this mean that just the 19 existence of a permitted project (assumed constructed) implies a given suite of impacts and effects? If so, what are the effects assumed?

- The final paragraph on page 4-73 and the top of page 4-74, in the Basin 9 summary section, suggests that there may be cumulative impacts of existing projects and that "...hydrologic results can also extend beyond the boundaries of the individual permitted areas." But it does not explain what these hydrologic results might be, how widespread their effects 20 might be, and how these potential hydrologic results may impact significant resources. This type of information is the crux of the PHMEIS. It should be fully explored in a 'Existing impact', and used to project 'Future impact.'

Similarly, on page 4-75 the idea that the impacts of a project may extend beyond the 'footprint' of a project is suggested, but this concept is not discussed in detail anywhere else in the document. This is an essential concept for exploring what environmental impacts are, and what future impacts might be. Page 4-75 also states that "potential for interaction between permitted project areas" is high in Basin 9. Details on how the projects may interact, what significant resources will be effected, and what the potential results of the interaction may be should be fully discussed.

- Section 4.8.6. Measuring management success, is a very important topic. The section does not clearly lay out the historical 'measure of success' from pre-permit times, the current 21 'measure of success' under the 404 permit program, and what 'measure of success' will be used

in future permit decisions. What does the existing monitoring data tell us about success at meeting management goals? If there is no data from existing permitted projects, and, therefore, there is no objective way to judge success, that should be clearly stated.

- We disagree with some opinion statements in the PHMEIS, such as this passage in section 4.8.6: "Data sets and other forms of objective documentation are rare. Thus, the debate about what the various forms of hydrologic management can or can't be expected to accomplish and what the corresponding impacts and effects are in any given situation continues (references.) And, Louisiana's coastal marshes continue to erode (references.)" We disagree with the beginning premise. Actually, there is probably more objective data that has been collected on marsh management itself, and on the response of vegetation, sediments and fisheries resources to marsh management-type manipulation than on any other restoration type except perhaps vegetative plantings. 22

- Page 4-83, recent work by Denise Reed, Nan Walker and other scientists working on sediment mobilization in Louisiana coastal marshes should be included here. Information on sediment mobilization and transport issue, was presented by researchers at the Geological Society of America conference in New Orleans, November 1995, and is probably available in published form. The implications of this work are very important to marsh management applications, especially in the delta plain. Comments by Andy Nyman, from the EPA 1994 structural marsh management workshop, are heavily used in this section. This commentary is seemingly given equal treatment as published work is in this section. Do the ideas and opinions in Andy Nyman's commentary exist in published reports? If so, they should be referenced as well. 23

- Sections such as 4.9.2 <u>Emergent vegetation on native, uneroded soils</u>, seems to bounce back and forth between anecdotal descriptions of process and impacts and evidence from published papers on what actual impacts have been observed. We suggest that all information on 'significant resources' be included in one area of the document. As an example, all information on emergent vegetation should be one subsection of 'significant resources', with several sub-subsections for any information that is unique to emergent vegetation in fresh, brackish, erodible soil, etc. 24

- Page 4-86 states that "...differences between managed and unmanaged areas are often observable." What "differences" are being alluded to in this passage? This section is an example of why this document tends to be very difficult to follow. The "differences" that are being discussed are never described! 25

- Section 4.9.4 <u>Marsh ponds/open water areas</u>. The discussion of the significance of this resource and how it relates to coastal restoration objectives, should be expanded. Open water is a significant resource for species diversity and larger animal use such as waterfowl. The PHMEIS states that management for waterfowl may attempt to achieve a 50 to 90 percent range for marsh area to pond area. However, if marsh management is done to promote emergent 26

vegetation as a marsh restoration project, it seems to be arguable that there should be a very high percentage of marsh in relation to pond as the management goal. This is another concern raised by the exclusive reliance on CWPPRA projects as proxies for future marsh management permit applications. CWPPRA projects will be done to promote emergent vegetation, therefore, should be expected to achieve high marsh to open water ratios.

- Section 4.9.6 Who are the 'several investigators' referred to here?

- To the three fisheries impacts related questions on page 4-93, we would add "how does 27
the timing and frequency of operation of marsh management structures effect migratory patterns
of fish and crustaceans into and out of management areas?

- Page 4-95, the paragraph discussing preliminary work by Hoese and Konikoff (1995,
galley proof) is confusingly written. Is the point of this section that, in the event of a severe
storm or a management structure failure, water will enter the managed area unimpeded,
therefore reintroducing fish species and erasing any physico-chemical effects from the 28
(previous) management? This impression stands in some contrast to the evidence observed in
some managed areas and in some impounded areas where management have been abandoned.
When storm events bring in water unimpeded, salt water stress and inundation stress has had
serious negative impacts on marsh health and has increased erosion and marsh loss, relative to
unimpounded areas also impacted by the storm event. For example, the discussion of project
SA-3 on page 5-44 explains that marsh loss and conversion from fresh to brackish marsh has
occurred in this managed area and "...some marsh loss and marsh-type conversion was attributed
to hurricane damages in 1957 and 1961." This implies evidence to the contrary of the Hoese and
Konikoff hypothesis.

- Section 4.9.12 Hydrology: Sediments, should cite the recent work of Denise Reed, Nan
Walker and other researchers working on sediment issues. The third paragraph discusses 29
sediment mobilization in storms, and their work should be discussed here. Perhaps it is being
alluded to here when it is stated "...dynamics of sediments...has been studied in part but is still
largely assumed." What studies? What assumptions?

- The statement in the last paragraph of section 4.9.13.2 seems to conclude that marsh
management may "perpetuate...marsh types" based on managment of salinity. Yet the
discussion of data on salinity levels from researches cited in the last paragraph of section 4.9.13 30
suggests otherwise. The research cited demonstrates that response of salinities to marsh
management practices is variable and seemingly difficult to control. Perhaps this is to be
expected based on the complex dynamics of the coastal system. The different conclusions that
can be drawn from these two sections should be reconciled.

- For clarity, on page 4-115, the sentence beginning "Phosphorus is not a limiting plant
nutrient..." should read "Phosphorus is not a limiting plant nutrient in estuarine systems but,..." 31

- In section 4.9.18, Primary Production, two questions are posed: (1) can marsh management enhance primary production? and (2) can this enhancement offset erosion?. The first question is answered in this document by pooled data in summary from several South Carolina researchers. The primary productivity was similar in managed and unmanaged areas, but the production in managed areas was shifted to benthic microalgae, phytoplankton and submerged macrophytes which compensated for lower production in emergent macrophytes. This evidence is used to conclude a "qualified yes" to question number 1. 32

This document's conclusion on the second question is not clear. However, this is an essential question, if not the key question regarding marsh management, especially in a CWPPRA or coastal restoration context. The importance of this question also requires careful survey of all available marsh management literature to attempt to craft an answer. Is the Lehto and Murphy, (1989) paper the only paper available that quantifies an increase in primary production (biomass of plant material)? The PHMEIS states that this was achieved in a pumped system, and results were not consistent. If this is the data available, perhaps the answer to question number 2 is a "qualified no." 33

- The meaning of the one-sentence section on Wildlife, fish, crabs and shrimp (4.9.19.3) must be clarified. "The most likely response is an unavoidable reciprocal, possible compensatory shifts in numbers and biomass and possibly species assemblages." Please explain this further. This very brief section assumes that the audience knows how the "unavoidable reciprocal" response manifests itself, for instance. 34

- It is not certain, and not explicitly supported by quantitative evidence presented in this PHMEIS, that the assumption made in the "management implication" statement in section 4.9.21.1.3 (page 4-127) is accurate. The assumption is that marsh management can suppress, stop, or reverse marsh losses, and prolong existence or shift to more productive marsh type. Prolonging and shifting is arguably supportable from evidence and experience, but evidence of marsh management techniques reversing marsh loss has not been presented. 35

- Socioeconomic sections like Flood control, Land use and Land loss, Mineral/petroleum production, Property value and ownership, etc. are critical issues. They are given cursory treatment in the PHMEIS. For example, Property value and ownership , section 4.9.21.7, only considers camps. It seems that a statistic here such as '70 percent of the coastal wetlands of Louisiana are privately owner' would be included at least. Obviously, the NOD's mandate as the lead federal permit issuing agency for marsh management projects does not allow the Corps to dictate policy on socioeconomic issues, nor should it. However, these socioeconomic issues create the framework that marsh management decisions must be made within, and the conflicts that inform it. The issues themselves should be discussed more fully. How different stakeholder concerns interact should be foremost; for example, the interactions between Mineral/petroleum production and Property values, should be considered in its complexities. 36

- Section 4.9.21.9 Employment and Labor Force, omits the effect of marsh management on
the fishing and fishing-dependent industries of south Louisiana. Studies done by fisheries
scientists (such as Herke) have shown that marsh mangement structures reduce fish and
crustacean production in managed areas. These reductions may be assumed to translate to
reduced opportunity for fishers to capture fish. These reductions may also be assumed to 37
translate through the economy and provide less economic opportunity for those who provide
supplies, maintenance, or processing for fishers. An economic investigation of this impact of
marsh managment is essential for this document. A 'back of the envelope' calculation using
literature values for reduction in fish and crustacean production, and projecting the possible
economic impact of increased acreage in marsh management on fishing and support jobs, should
be added to this section.

- The two issues in section 4.9.21.11.2, Protecting Values..., should be separated out to the
previous subsections they fit under such as Access and Mineral extraction. It would be
preferable for all of this discussion to be reorganized and included in a reconstructed 38
'Significant Resources' section for ease of use and readability. Additionally, this section states
that "this situation creates the apparent paradox that the interests of some state agencies could
actually conflict with the interests of other state-level agencies." While it is true that the
interests of state agencies may at times actually conflict, the same is true of Federal agencies,
whose objectives may also conflict, and should be mentioned.

- There are many complicating factors regarding coastal land and taxes. What is the 39
evidence to support the simplified assumption that successful management efforts have positive
effects on the tax base, in section 4.9.21.12 ?

- The simplified assumption that successful management efforts have positive effects on
growth, in section 4.9.21.13 is not justified with any evidence. The 'converse' of the
assumption that marsh management contributes to 'growth' may very well be true under current
conditions because of existing impacts on fisheries. However, at this time there may not be 40
sufficient evidence to draw either conclusion. Therefore, the complexities of the issue should be
discussed, economic figures should be used to make the arguments, but an assumption based on
no evidence should not be asserted.

- The simplified conclusion in section 4.9.21.14, Health and Safety, should also be
supported by evidence. This section assumes marsh management may reduce coastal flooding. 41
If there is any evidence that marsh management improves the coastal flooding situation this, it
should be provided.

- In the Environmental Justice section of the PHMEIS (4.9.21.18) it is asserted that marsh
management in Louisiana "is not practiced in a way that adversely or environmentally affects 42
any specific groups or individuals." However, it can be argued that marsh management has and
does adversely impact certain groups such as commercial, recreational, or subsistence fishers
who no longer have access to navigable waterbodies because of marsh management structures.

In addition to access, these groups see the economics of the fisheries market change as public resources such as migratory fish and shrimp become effectively privatized as a result of impoundment. It can also be argued that large coastal areas under marsh mangement may reduce fish and crustacean productivity of an area outside of the management site, thereby impacting fishers as a group as well. Whether or not this potential impact on groups such as fishing communities or subsistence fishers can or should be considered an "environmental justice" issue is unclear. However, these impacts should be discussed in the appropriate section, and the question should be raised here. 42 con't'd.

- In Table 4-1, when a 'Management Assumption' is marked as 'conclusively demonstrated' what are the references? The references must be identified for these assumptions. This table format is very complicated and confusing. Many of the comments in the tables are unclear. For example, what is meant by the statement on page 4-139: "HYDROLOGY: flooding Frequency MA: Only in some cases, typically reflective of project purposes, are periodic elimination of flooding required:monitored. S- Conclusively demonstrated"? What is the reference that provides conclusive demonstration? 43

- In Chapter 5, in the descriptions of potential future CWPPRA marsh management/ hydrological restoration projects, a particular sentence is repeated in almost all of the project descriptions. It is "The frequency, direction and duration this management area would retain with the unmanaged estuary would be reduced to what would occur during those occasions when tides rose to levels that overtopped the structures or the marsh." This sentence is even included on many projects such as PO-11 that are described as hydrologic restoration. This seems directly inconsistent with an acceptable definition of 'hydrologic restoration'. If hydrologic restoration is a project goal, then it should not isolate the managed area from the estuary, but restore the area to a 'natural' hydrological pattern including connection with the estuary. This, again, points to the need to properly define 'marsh management' and 'hydrologic restoration.' This sentence only implies that any associated impacts from isolating a portion of coast land from the greater estuary, such as reduction of fish and crustacean production and limited access to navigable waterbodies will be experienced. This Chapter is supposed to be on impacts and effects of prior and future action, yet in the project-by-project descriptions, no discussion of the actual experienced or expected project impacts on the environment are provided. Only this repeated sentence is used to imply that impacts may occur. 44

- Two contradictory impact statements are included in the description of project PBA-32, page 5-9. 45

- What is meant by the sentence on page 5-14: "Internal marsh losses may continue to occur, but at a rate that can't be detected"? Confusing sentences such as this and/or typographical errors are frequent in the document. 46

- What are the 'project interactions' referred to in the section 5.1.1.6.2 (page 5-27) statement "Appreciable potentials for project interactions and interdependencies, based on 47

spatial patterns, were readily apparent in basins 4 and 5 and suggested in basin 7"? As this document is a PHMEIS that should describe potential cumulative environmental impacts of marsh management, does the potential for 'project interaction' imply cumulative environmental impact, and of what type?

- The Summary for the Calcasieu-Sabine basin, section 5.1.2.2.4, explains that under the CWPPRA project assumption used in this document "Nearly every marsh/pond acre of this basin would be brought under management. Therefore, the consequences of management are expected to be basin-wide and even more biologically, socially, and economically intensive than the 48 expected consequences from management in basin 4 (Barataria) and basin 5 (Terrebonne)." There is no further listing or discussion of what those 'biological, social, and economic' impacts might be. The reader is left to try and infer what the impacts might be from the numerous and scattered sections on biological, social, and economic issues throughout the PHMEIS. The writers of this section must have had some 'consequences' in mind when they wrote this section. What those consequences are should be listed or described here.

- A discussion of future conditions in basin 5 and 9, Page 5-54, states "A possible consequence would be to further disrupt the hydrology of the remaining unmanaged marsh." 49 Nowhere in the PHMEIS have we found further discussion of this possibility. It should be investigated in the previous sections on hydrology and significant resources as a possible impact of existing and future marsh management.

- The need for appropriate definitions is highlighted by this sentence on page 5-55 "Hydrologic restoration would also be the management option of choice for reestablishing 50 former or upgrading existing actively managed efforts, some of which were/are marsh management projects." This seems to state that the terms are interchangeable.

- Table 5-20 titled Cumulative Effects, is very difficult to follow. Very few actual effects are included. There is much equivocating text for why effects information is unclear, such as 51 paragraph number 2 under 'Historic'- 'Coastwide'- 'Submerged/Aquatic Vegetation' (page 5-63). This paragraph that appears frequently throughout the table, creating much unnecessary repetition.

However, many general insights found nowhere else in the document are placed in the table. For example, the concepts in paragraph 5,6,7, and 8 in the 'Future', 'Coastwide', 'Emergent Vegetation on Uneroded Soils' section of the table are not in the text discussion on 'significant resources', or in the general text of the document. These concepts warrant expansion and further discussion in the text of the document. The information presented here does not lend itself to table form. We recommend that the information in the tables be included in the appropriate section of the text. As another example, issues such as that suggested by paragraph 7 under 'Historic and Future'- 'Coastwide'- 'Wildlife' in table 5-20, should be expanded on in an improved Socio-economic section. The issue of distribution of benefits from marsh management, in this case the reduction in fish and crustaceans offset by other wildlife

benefits, is an important concern because it transfers the benefit from one economic interest group to another.

- In several places in the 'Fish, shrimp and crabs' section of table 5-20 it is stated that "...monitoring results... are virtually non-existent", to determine fisheries impacts. Monitoring data from permit-required monitoring reports may be non-existent, but scientific study of fisheries impacts is plentiful. Studies quantifying fish and crustacean impact are readily available. This data and conclusions drawn in the studies must be included in the PHMEIS. 52

- The expected goal of a "Cumulative Effects"section is not achieved in Table 5-20. For example, the 'Hydrology:Water' section, 'Historic and Future' paragraph 3, implies "significant changes" but does not describe them. 'Hydrology:Sediments' section says that "significant resources probably have already been significantly modified in basin 9..." but does not say how, or if this is good, bad or neutral, or possible in other basins. Paragraph 2, 'Coastwide'- 'Socioeconomics' refers to "...concerns over economic effects...that have already been expressed over the years..." but does not describe what those concerns were, nor does the rest of the document. Text such as that in these examples does not provide useful information on "Cumulative Effects." 53

- The information from Appendix H 'Basin-by-basin landscape Characterization', such as that on impacts from altered hydrology in paragraph two, page 4, should be included in the 'significant resources' sections for emergent vegetation, marsh soils, and in other appropriate sections of the document. Some information is unique to this appendix, such as the statement on page 43 (Appendix H) "One problem with these types of projects (barriers to restrict free water exchange) is the difficulty in maintaining favorable water levels within the managed areas. High relative water levels may lead to marsh loss or make restoration of marsh areas difficult." This information, with references, should be included in the document text on 'significant resources' and 'impacts'. 54

- In Appendix J, Socioeconomics, section 3.4 Mineral Production, it should be stated that an economic incentive to maintain clear ownership of a coastal land parcel by leveeing exists because ownership (in theory) reverts to the state when land becomes water, yet open water behind a levee could remain private. Section 3.1.2 Recreational, Fish and Wildlife, should contain a discussion of 'public trust' issues such as access to migrating fish and crustaceans, and access to navigable waterbodies. This can be negatively impacted by marsh management. Section 3.9, Employment/labor force should mention that jobs in fishing and fishing-support services may decline due to increased prevalence of structural marsh management. Section 3.12, Tax revenues, appears over simplified as there are many complexities to Louisiana tax laws and land laws, in code and in practice. This Socioeconomic section does not cover many complexities of the subheaded topics. It should be improved. 55

- In appendix M, Management Structures, what are the reference citations in section M-5? Especially the citation where the text states "...provides the basis for the assertion that this form of management can reverse marsh losses (NRCS ----)"? 56

- We agree with the last paragraph of section 5.4, the 'Conclusions' section. We agree that demanding greater compliance with monitoring reports, implementing better designed monitoring programs, and conducting or sponsoring additional rigorous scientific studies would aid in improved decision making. Programs to implement these ideas should be initiated. The Corps should continue to evaluate marsh management permit applications on a case-by-case basis, taking into full account existing marsh management efforts in the area and cumulative impacts. 57

- The report by the U.S. Department of Interior, Mineral Management Service, Gulf of Mexico OCS Region, titled A Study of Marsh Management Practice in Coastal Louisiana, May 1991, should be reviewed and cited in the PHMEIS. There are several map plates associated with this document. Plate 7 maps marsh management areas in coastal Louisiana, including existing federal and state refuges, planned Soil Conservation Service marsh management sites, and sites of permit applications. Plate 8 maps marsh management feasibility and delineates areas where soils may not be suitable to support marsh management associated levees and structures. Plates 7 and 8, should be updated in this PHMEIS. This could provide the basis for a much needed fold-out map for the PHMEIS that would map existing management sites, permitted sites, and areas where marsh management may be most applicable. 58

In conclusion, we thank you for the opportunity to review and comment on this document. Please contact me at the Coalition (505) 344-6555, if you need clarification on any of these comments. Additionally, we would be pleased to work with you in implementing any of these comments.

Sincerely,

Ann Burruss

Ann Burruss
Science & Technology Director

c: Board Members

S.3.6. Tulane Environmental Law Clinic (Tulane)

1. - 2. Noted, no action required.

3. Noted, see Sections 5.1.1.1. - 5.1.1.4., as well as Tables C-1. - C.8., and Section 5.1.1.5.

4. Somewhat of an overstatement- many of the effects are conceptually or qualitatively characterized.

5. Noted, see Section 5.8.1.

6.1. NOD is obligated to characterize all effects, beneficial as well as *adverse.*

6.2. NOD was not prevented from making effects determinations.

6.3. - 6.5. See Sections 5.1.1., 5.6.21., 5.8.1.

7. Noted, see Section 5.8.2.

8. Disagree, see 6.3.

9. Noted, see 6.1.

10. Object to the use of the word "vital". "Useful would be a more accurate representation.

11. Disagree, see Section 5.1. Also, funds were specifically allocated for NOD economists to characterize the existing socioeconomic setting at a programmatic level. Funding was based upon cost estimates provided by the economists. The economic analysis did <u>not</u> conclude that future impacts could not be predicted, as alleged in the comment. However, the analysis did reveal that much more could be learned. NOD concluded that socioeconomics could be a fertile area of future elective academic inquiry for any entity so included.

12. Noted. The budget for regulatory activities, including enforcement actions, is established by Congress.

13. Noted, see 5.8.

14. The F-PHMEIS contains an expanded discussion of "monitoring." There is no need to delay publication of that information.

15. Opinion noted, but disagree. See also Appendix P.

16. A restatement of issues already address in 4. thru 16., inclusive.

17. Comment noted, but disagree with opening assertion.

18. Disagree, see Appendix M of draft and Appendix B of F-PHMEIS. Also, see Section 5.6.

19. Disagree, and see Sections 4.3.4., 4.3.5., 4.3.5.2. (especially 4.3.5.2.3.), 5.5.2.2., 5.5.2.3.,

20. SW (Bayou Terrebonne)332 was not a HM permit, but NOD sent a letter to Louisiana State Lands as a matter of standard practice as outlined in Appendix P.

21. Noted, see, for example, 5.7.

22. Restatement of issues 17 through 20.

23. Noted, agree.

24. Suggesting that "impoundment" is the norm **does not** match the permit record. "Semi-impoundment", a very different configuration, would be a better representation of a more common historic situation.

25. Noted, disagree, see Chapter 3.0., especially, Section 3.2.

26. Noted, and disagree. The limits of such an endeavor would extend way beyond the scope of the PHMEIS. See Chapter 3.0.

27. Noted, see Chapters 4 and 5. "Impoundment" is not addressed in the PHMEIS.

28. Noted, see Chapter 3.0., especially Section 3.2.1.

29. Disagree, but see, for example, 5.8 in F-PHMEIS.

30. Noted.

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COMMENTS:

COMMENTS OF
SIERRA CLUB-DELTA CHAPTER, INFORMED CITIZENS OF LAFOURCHE, LOUISIANA ENVIRONMENTAL ACTION NETWORK, ORLEANS AUDUBON SOCIETY AND TERREBONNE FISHERMAN ORGANIZATION

on

U.S. ARMY CORPS OF ENGINEERS, NEW ORLEANS DISTRICT'S

DRAFT PROGRAMMATIC HYDROLOGIC MANIPULATION ENVIRONMENTAL IMPACT STATEMENT
(OCTOBER 1995 DRAFT)

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January 2, 1996.

COMMENTS ON
U.S. ARMY CORPS OF ENGINEERS, NEW ORLEANS DISTRICT's
DRAFT PROGRAMMATIC HYDROLOGIC MANIPULATION
ENVIRONMENTAL IMPACT STATEMENT
(October 1995 Draft)

The Sierra Club-Delta Chapter, Informed Citizens of Lafourche, Louisiana Environmental Action Network and Terrebonne Fisherman Organization (collectively "Citizen Groups"), through undersigned counsel,[1] submit these comments on the Draft Programmatic Hydrologic Manipulation Environmental Impact Statement ("DPHMEIS") (dated October 19, 1995) prepared by the United States Army Corps of Engineers, New Orleans District ("NOD").

INTRODUCTION

These comments are submitted on behalf of groups with diverse concerns about the health and vitality of Louisiana's coastal resources. Citizen Groups' members utilize Louisiana's coastal resources for aesthetic enjoyment, recreation, subsistence and commercial enterprise. Members of Citizen Groups engage in both consumptive and non-consumptive activities in Louisiana's coastal wetlands, including hunting, fishing (commercially, recreationally and for subsistence), bird-watching, boating and other activities. Accordingly, Citizen Groups are particularly interested in the ability of Louisiana's coastal wetlands to

[1] The Tulane Environmental Law Clinic submits these comments on behalf of the above mentioned clients, not on behalf of Tulane University or Tulane School of Law.

continue to provide their members with the natural resources that are the basis of these activities.

As the NOD has correctly recognized, the actions that are the subject of the DPHMEIS may have a significant impact on the quality of the environment when viewed in the cumulative context, if they have not already.[2] For this reason, and because of the acknowledged scientific and socioeconomic controversy surrounding activities such as "marsh management", Citizen Groups have for some time been concerned that the activities covered by the DPHMEIS should be assessed in an environmental impact statement. In fact, most of the Citizen Groups have, in the past, expressly requested the completion of an environmental impact statement addressing activities that are covered by the DPHMEIS.[3] 1 cont'd.

As a preface to more specific comments concerning this issue, the NOD should be aware that Citizen Groups have actively sought to make the preparation of the DPHMEIS easier and more effective in serving its intended purpose of allowing informed decision-making by the NOD. As the NOD has repeatedly noted in the DPHMEIS, there is a lack of information on the effects of 2

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[2] *See* DPHMEIS-2-2..

[3] *See* March 25, 1994 and May 13, 1994 letters to Colonel Kenneth H. Clow of the NOD from the Tulane Environmental Law Clinic and Colonel Clow's May 26, 1994 response. Each of these documents is already in the Corps' files, and Citizen Groups request that these documents be incorporated into the administrative record of this proceeding.

hydrologic manipulation projects, such as marsh management projects.[4] As recognized by the NOD, this lack of information is largely due to the failure of marsh management permittees to comply with the monitoring and reporting requirements of their permits.[5] Citizen Groups have several times in the past brought this pattern of non-compliance to the attention of the NOD, through notices of intent to sue under the provisions of the Clean Water Act, as noted above and in footnote 3. In the most recent communication with the NOD, Citizen Groups identified a large number of marsh management permittees that appeared to be in noncompliance with the reporting and/or monitoring requirements of their permits.[6] In that letter, Citizen Groups offered to provide the Corps with a copy of an extensive database that identifies each marsh management project in Louisiana and the extent of compliance with permit conditions. The NOD has not, to date, responded to this communication and, in particular, has failed to request a copy of the marsh management database.

2 cont'd.

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The lack of compliance with the reporting/monitoring requirements of marsh management permits, coupled with other acknowledged gaps in vital

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4 *See, e.g.,* DPHMEIS-1-2.

5 *See, e.g.,* DPHMEIS-4-54 ("The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). Our review of our database revealed that compliance with permit conditions requiring monitoring and report submittals was poor."); DPHMEIS-4-55 ("Compliance with permit conditions requiring monitoring and report submittals was poor.").

6 *See* October 19, 1995, letter to Colonel Clow from Tulane Environmental Law Clinic. This letter is already in the Corps' files, and Citizen Groups request that it be incorporated into the administrative record of this proceeding.

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information concerning the effects of hydrologic manipulation projects[7], has a significant impact on the issues that must be addressed through the DPHMEIS. This issue is discussed in greater detail below.

A. Lack of Information Relating to the Effect of Marsh Management and Other Hydrologic Manipulation Projects Requires Full Compliance with 40 CFR 1502.22

The NOD acknowledges that the effects of hydrologic manipulation projects such as marsh management are still unknown. As noted at §5.3 of the DPHMEIS, "the long term and system wide biological and ecological effects of marsh management in Louisiana remain to be conclusively documented." 4

Elsewhere, it is acknowledged that "[e]xisting observation, studies, experiences and opinions are not definitive," thereby precluding the development of answers to the fundamental questions that should be explored by the DPHMEIS -- Do marsh management and hydrologic restoration projects work, and what are the adverse impacts associated with the projects?[8] 5

While Citizen Groups recognize that "a single defining statement applicable to all possible situations"[9] may never be possible, the NOD is nonetheless obligated to determine what reasonably foreseeable adverse effects 6.1

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[7] *See, e.g.,* DPHMEIS at §§ 4.5.1.3; 4.5.1.4; 4.5.2.3; 4.5.2.4. (lack of comprehensive compilation of species specific responses to factors such as salinity changes and flood levels in different habitat settings -- the types of impacts that could occur through hydrologic manipulation.)

[8] DPHMEIS-5-94 (§5.4)

[9] DPHMEIS-5-94 (§5.4)

may result from hydrologic manipulation projects.[10] The NOD was obviously 6.2 prevented from making such a determination in the DPHMEIS by the lack of 6.3 information concerning the effects of the numerous projects it has already permitted, a situation for which the permittees and the NOD are *jointly* responsible. As noted in §4.8.2 of the DPHMEIS, "[t]he permit data base is a very poor tool with which to infer success of the permitted activity relative to 6.4 stipulated purpose. *Monitoring reports, typically required as permit conditions, were intended to provide those insights.*" (emphasis supplied).

Unfortunately, the very information that was to provide the answers explored by the DPHMEIS is missing due to widespread noncompliance with monitoring and reporting conditions of permits. Again, the NOD has expressly recognized this problem, noting, for example, that "[t]he historic permit data 6.5 base was uninformative about the success any project achieved relative to stipulated project purpose(s). Our review of our database revealed that compliance with permit conditions requiring monitoring and report submittals was poor." (DPHMEIS-4-54); *see also,* PDHMEIS-4-55 ("Compliance with permit conditions requiring monitoring and report submittals was poor.").

It is now, and always has been, within the power of the NOD to compel 7 compliance with the monitoring and reporting conditions of marsh management permits. Given every opportunity to do so, however, the NOD has failed to 8

[10] *See* 40 CFR 1502.1

rectify this problem.[11] As a result, information that could very well have provided answers to the fundamental questions that should be answered by the DPHMEIS is lacking. Section 1502.22 of 40 CFR addresses this situation as follows: 8 cont'd.

> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.
> (a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency ***shall*** include the information in the environmental impact statement. (emphasis supplied).

Only where the costs of obtaining such information are exorbitant, or the means of obtaining the information are unknown may the agency not include such information in the environmental impact statement. 40 CFR 1502.22(b). In this case, the agency is obligated to explore catastrophic adverse impacts that could result from the permitted activity. 40 CFR 1502.22(b)(4). 9

In the present case, the NOD has made clear that information vital to its evaluation of the effects of marsh management is lacking. 10 It has not, however, complied with the remaining mandates of 40 CFR 1502.22. The means of obtaining the information relevant to the impacts and effects of marsh management projects is known -- monitoring and reporting by marsh 11

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[11] Again, NOD is reminded that Citizen Groups have made efforts to assist the NOD in obtaining the information that could have been utilized in the preparation of the DPHMEIS (*see* footnote 6, *supra)*, and Citizen Groups repeat their offer to make their marsh management database available to the NOD.

management permittees. Additionally, there can be no argument that the costs of obtaining this information are exorbitant, since numerous marsh management permittees are already required to monitor and report the effects of their projects. All that would be required of the NOD is enforcement of the already issued permits. 12

Citizen Groups strongly urge the NOD to comply with the mandate of 40 CFR 1502.22 by requiring compliance with the reporting and monitoring requirements of existing marsh management permits and incorporating this information into its assessment of the effects of hydrologic manipulation projects. 13
Although a delay in completion of the DPHMEIS could result from the decision to incorporate this information into the document, the benefits of incorporating this information into the document would in all likelihood outweigh any drawbacks that may result from delay. 14

Without this information, the NOD will be seriously hampered in its ability to conduct the required assessment of cumulative impacts resulting from hydrologic manipulation projects, whether in the DPHMEIS *or in case-by-case assessments for individual permit applications.* Citizen Groups feel that enforcement of the reporting requirements in marsh management permits is a prerequisite to being able to evaluate the environmental impacts of the NOD's marsh management permitting program. For this reason, the NOD should refrain from issuing additional marsh management permits until it is able to fully ascertain the environmental impacts of the marsh management projects it 15

currently authorizes. This alternative should be fully explored in the final environmental impact statement.

B. The Assessment of Adverse Impacts of Hydrologic Manipulation Projects Should Include an Evaluation of the Effect of Failure to Comply With Operational Conditions

Related to the issue of existing marsh management permittees' apparent failure to comply with monitoring and reporting conditions of their permits is the issue of compliance with substantive operational conditions of the permits. In many marsh management permits, for example, there are requirements that water control structures be operated in such a manner as to allow the ingress and egress of marine organisms that utilize the marsh, in addition to operational requirements that are intended to serve the primary goal of enhancing waterfowl habitat.[12] In effect, such conditions are intended to mitigate the adverse impacts to nontarget organisms that are expected to occur when managing for a particular (target) resource. 16

In light of the apparent widespread noncompliance with monitoring/reporting conditions, questions relating to existing permittees' compliance with operational requirements arise. For example, what are the levels of compliance with operational conditions intended as mitigative measures, and what adverse impacts are associated with such noncompliance, if

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[12] *See, e.g.*, LMNOD-SW (Vermilion Parish Wetlands) 260, conditions, incorporating Coastal Use Permit (CUP) No. P880862 conditions. The CUP conditions mandate that in certain periods the flapgates be locked open to "allow ingress & egress of estuarine organisms."

it occurs? Without information relating to the extent of compliance with operational conditions, the NOD cannot adequately evaluate the adverse impacts associated with hydrologic manipulation projects. This information could easily be obtained through enforcement of the monitoring/reporting conditions of 16 cont'd. existing permits and should be incorporated into the DPHMEIS. Noncompliance with operational conditions of hydrologic manipulation permits, and the adverse impacts that could result therefrom, is reasonably foreseeable in light of the existing permittees' poor history of compliance with other permit conditions. Accordingly, Citizen Groups request that the NOD evaluate the extent and impact of such noncompliance in the DPHMEIS.

C. The DPHMEIS's Treatment of the Issue of Public Access to Public Trust Resources is Inadequate

The DPHMEIS explores public access issues in an unreasonably cursory 17
manner. It lists public access as consisting of three distinct components: 1) liability; 2) vandalism; and 3) the harvest of marsh dependent resources. The DPHMEIS then articulates the perspectives of landholders and the general public regarding these issues. But the DPHMEIS fails to mention that structures used in marsh management projects can impede public access to state water bodies. 18
This issue is of great importance because public use of these water bodies is guaranteed by the Louisiana Constitution and the Louisiana Civil Code. Further, the DPHMEIS does not adequately discuss the ability of marsh management 19
programs to impede the flow of fishery resources from private property to areas

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where such resources are accessible to the public.

The DPHMEIS contends that these such issues are legal questions "that need not and should not be resolved by the [NOD]." However, this position is inconsistent with the NOD's position in previous permitting matters. For example, in its decisional process on Permit SW (Bayou Terrebonne) 332, the NOD expressly evaluated the issue of public access rights, going so far as to 20
request an opinion of the Louisiana Attorney General concerning same.[13] In declining to meaningfully assess this issue in the DPHMEIS, the NOD fails to fully evaluate the potential social impacts of marsh management projects on the public, which relies on fishery resources for recreation, commercial enterprise and subsistence.

EIS regulations require that the NOD consider the impact of marsh 21
management on historic and cultural resources.[14] Having identified a significant impact on the natural environment, the NOD must fully address the social and economic impacts of such projects. Clearly, the DPHMEIS's discussion of public access issues is inadequate. Citizen Groups strongly urge the NOD to evaluate 22
this issue in greater detail to recognize that an assessment of the public's rights of access to public trust resources is a vital aspect of the public interest analysis that must be undertaken before deciding to issue permits for hydrologic

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[13] The Attorney General responded to this request by letter dated July 27, 1990. The NOD's request for this opinion, contained in the NOD's files, is to be considered incorporated into these comments by reference.

[14] 40 CFR 1502.16(g).

manipulation projects.

D. The EIS Should Assess in Detail the Impact of Active Marsh Management on the Ability to Successfully Implement Large Scale Water and Sediment Diversion Projects that May Have a Greater Likelihood of Forestalling or Reversing Erosion

Section 4.3.5.1.2 of the DPHMEIS recognizes that "active marsh 23
management" involves efforts to mute the natural rhythms and dynamics of the
hydrology of the marsh. This effect is often achieved through the simple process 24
of hydrologic isolation, or impoundment of the marsh. In §3.4.3.6 of the
DPHMEIS, the NOD expressly notes that it would not consider the issue of large
scale, uncontained diversions of water and sediment in the DPHMEIS. However, 25
this issue cannot be ignored since the process of permitting a marsh
management project may make it more difficult to develop or successfully
implement large scale, uncontained diversions of water and sediment as a
means to combat erosion. The question that should be explored is how the
Corps' permitting program relates to overall efforts in Louisiana to prevent
coastal erosion. In particular, whether, and to what extent, does permitting 26
active marsh management projects preclude (or impact) the possibility of
implementing projects that impound areas which receive sediment-rich
freshwater? Might marsh management projects exacerbate subsidence in
adjoining, non-impounded areas? Similarly, impounding marsh areas 27
susceptible to salt water intrusion could increase intrusion rates in adjoining non-
impounded areas. These issues are not addressed in the draft EIS. Section 102 28

of the National Environmental Policy Act, by requiring the environmental impacts 28 cont'd.
of a proposed project be analyzed to the "fullest extent possible," demands that such potential adverse environmental impacts be discussed.

E. The EIS Should Address the Ecological Trade Offs Resulting from Marsh Management Projects

The draft EIS also fails to explore the ecological trade-offs that can accompany decisions made by resource managers to favor a particular resource. The Environmental Protection Agency's involvement in the Point au Fer Island marsh management project illustrates this problem. EPA proposed the "elevation" of this project due to concerns that in favoring waterfowl habitat the project would actually exacerbate marsh loss and limit the access of marine 29
organisms to valuable habitat. The DPHMEIS should therefore evaluate the potential adverse environmental impacts of projects managed exclusively for waterfowl habitat or any specific resource on other marsh resources.

CONCLUSION

While Citizen Groups are pleased that the NOD has finally begun to evaluate the cumulative impacts of its marsh management decisions, it is clear that the DPHMEIS has failed to address many important issues. Citizen Groups 30
respectfully request that the NOD fully address and incorporate each comment set forth above in the final EIS, and provide Citizen Groups with written notice

when the final EIS is issued.

Respectfully submitted,

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